Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVIII. MARCH, 1925 No. 3

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Contracts Awarded

ROADS AND STREETS

Ala., Troy—Couch Constr. Co. awarded contract for street paving, including Thompson, Park, Love, etc., at $98,000.

Ark., Little Rock—M. D. L. Cook, Southern Tr. Bldg., Little Rock, awarded contract by Dist. Bd. of Commrs. and State Hwy. Dept., at about $98,900 for 5 miles grading and concrete work on Little Rock-Spring Lake road—Arch Street to Granite Mountain.

Cal., Fresno—Calif. Rd. & Impvt. Co., Box 501, Fresno, award. contract by County for impvt. of Van Ness Blvd.—Harvard St. to Shields Avenue—R. D. I. No. 6, at $35,020.50; 107,300 sq. ft. 1 1-2 ins. Warrenite pavement on 2 1-2 in. asph. conc. base, etc., etc.; C. M. Thompson awarded contract at $171,937 for impvt. of Van Ness Blvd.—Shaw ave. and other streets in R. D. I. No. 7, at $171,-937; 812,650 sq ft. asph. conc. base with 1 1-2 in. Warrenite surf., etc., etc.

Cal., Los Angeles—Peter Reach, 612 New High St. awarded contract by Bd. of Public Works for conc. pavement, curb, walk, etc., in portion of James street, at $9,043; Griffith Co., 502 L. A. Ry. Bldg., contract for impvt. of alley so. of Shepherd St., at $3,131, and at $272,439 for impvt. of Hollenbeck Ave.—Mines Ave. to Rio Vista Ave.; P. J. Alomadzich, 821 Yale St., contract at $7,449 for curb, gutter, walk, oiled rdway., etc., in Hamlet St.; Chas. T. Salata, 5161 E. 6th St., contract at $2,697 for conc pavement, etc., in Terr. $2; C. W. Shafer, 3301 S. Hill St., contract at $2,702 for conc. pavement, oiled rdway, curb, etc., in portion of Court St.; Griffith Co., Los Angeles, contract for conc. pave., etc., in alley so. of 38th St., betw. Pacific Ave. and 283 ft. east, at $1,138; Jno. Farquhar, Box 454, Lankershim, contract for conc. pavement, curb, etc., in Wit Pl.—Sanborn Ave. to Manzanita St., at $1,171; Channel Constr. Co., 1030 Bank of Italy Bldg., contract by Bd. Pub. Wks., at $62,370 for grading in Beacon St.—Santa Cruz to 4th St., San Pedro, at $62,370.

Cal., Sacramento—S. Wright Jewett, 600 S. Brand Blvd., Glendale, awarded contract at $250,754 for 16.13 miles graded roadway in Los Angeles Co.—Arroyo Sequit to Las Flores Canyon—through Malibu Ranch.

Fla., Bartow—Polk Co. Bd. of Commrs., let contracts for 8 roads in Bartow-Lake Wales Spcl. Rd. and Bridge District No. 11; Rd. No. 1, widen main road betw. Bartow and Lake Wales, West Construction Co., Bartow, at $311,850; Roads No. 2, 3, 4, 5, to McDonald Construction Co., Lakeland, at $244,035; Nos. 6, 7 & 8 to Stidham & Hughes Construction Co., Bartow, at $152,451.

Fla., Clearwater—Pinellas Co. Commrs., let contracts for 15 roads in Spcl. Rd. & Brdg. Dists. No. 8 near Dunedin and 6, nr. Clearwater, as follows. Cone Bros., Caesar and Walton Sts., Tampa, at $250,697, for asphalt blk. surface on 2 roads in District No. 6; Morgan-Hill Paving Co., Graham Bldg., Jacksonville, at $251,032 for bitum. macadam on 4 roads in Dist. No. 6; Warren & Carroll, $366,019 for asphalt blks., on 4 roads in Dist. No. 8; Morgan-Hill Co., Graham Bldg., $133,603, to repair 5 roads in Dist. No. 8; Luten Bridge Co., Palatka, $20,000 to repair bridges in Dist. No. 6.

Fla., Palatka—T. B. Gillespie, Palatka, awarded contract by City for abt., 50,000 sq. yds. curb, gutter and pavement on various streets here, at $138,000.

Fla., Sarasota Heights—L. E. Reno, Sarasota, awarded contract to pave, drain, curb and lay walks in Desoto Park and Bahia Vista, Citrus and Alta Vista Aves., est. cost, $84,000.

Fla., Tampa—Cone Bros., Caison & Walton Sts., awarded contract to pave 4 streets with asphalt blks. on crushed rock base, at $325,000; McDonald Construction Co., to pave street in Temple Terraces section.

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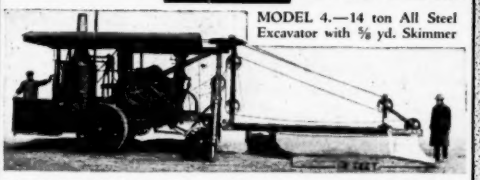

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Keystone stands on the solid. No cribbing needed, no danger from cave-in, of machine sliding into excavation. Any width or depth to 20 feet. There is 4 feet of water in this 12 foot ditch. The Keystone is adapted for hard going among roots, boulders, etc., and cleaning out blasted rock.

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One Car—Steam Melting

Capacity 2000 square yards 2-inch top daily.

Over 300 plants in successful operation.

Cummer plants never wait for hot sand.

Prompt Shipment on All Plants.

The F. D. Cummer & Sons Co., Cleveland, Ohio

Fla., Vero—F. W. Long & Co., 207 Realty Bldg., Jacksonville, awarded contract to pave with water-bound macadam, lay curbs and build culverts, at $163,766.

Ill., Quincy—Bauer, Johnson & Co., Quincy, awarded contract for paving various streets here; 40,855 sq. yds. asphalt, at $81,416; Western Asphalt Paving Corp., 1st & Nebraska Sts., Sioux City, Ia., contract for 25,302 sq. yds. asphalt, at $61,000; P. Simons, Quincy, awarded contract for 11,140 sq. yds. concrete surf., at $26,353; W. Wells, local, contract for 1,290 sq yds. concrete, at $2,889.

Ill., Springfield—Following contracts let by Department of Public Works & Bldgs., Div. of Hwys.: Secs. 25 and 27, St. Clair Co. pavement, to Mautz & Oren, Inc., Effingham, Ill., at $262,800; Secs. 23, 25 and 26, McHenry & DeKalb Cos. pave., to Harrison Engrg. & Constr. Corp., Kansas City, Mo., at $372,324; Secs. 35, 37, 38 and 39, Ogle-Winnebago Cos. Ogle, and Ogle-Lee Cos., pave., to McCarthy Impvt. Co. Davenport, Ia., at $604,320; Sec. 77A, Winnebago Co., grading to Otto McMahan, Rochester, Ind., at $247,500; Sec. 27W, McHenry Co., pave. to McCarthy Impvt. Co., Davenport, Ia., at $8,972; bridges to Ferguson Constr. Co., Rockford, Ill., at $97,242; Sec. 77B, Winnebago Co., to Ill. Steel Brdg. Co., Jacksonville, Ill., at $6,153 on Sec. 3C, Mason Co., to Zinimerly Brdg. Co., Paris, Ill., at $10,871. Sec. B. Mason Co., Sec. 24, McHenry Co. pavement to Harrison Engr. & Const. Corp., Kansas City, Mo., at $163,099; Sec. 18, Pike Co. pave., to Edw. J. Eiff Co., Quincy, Ill., at $201,792; Sects. 2, 3, 28 White, and 29, Salina-Gallatin-White Counties, pavement to Ransom & Sherwood, Palestine, Ill., at $344,000; Secs. 28 and 29, LaSalle and LaSalle-Livingston Counties, pave., to W. D. Lonergan Constr. Co., Streator, Ill., at $217,000; bridges on Secs. 8B and 8C, Adams Co. to A. Olson Constr. Co., Waterloo, Ia., and Vincennes Bridge Co., Vincennes, Ind., at $28,309 and $14,975, respectively.

Ill., West Chicago—Gund-Graham Co., Freeport, awarded contract for grading and conc. surfacing 22,345 sq. yds. Southwest Dist., including Milo Ct. Norris, Sherman, Clara, Harrison, Church and Ann Sts., at $79,047 and 9,209 yds. Sophia and Ann Sts., York and Fairview Aves., at $31,545.

Ind., Warsaw—E. A. Gast, Warsaw, awarded contract for conc. paving in Kosciusko County; 29,842 sq. yds. on Minear Rd., at $62,500.

Ia., Burlington—Wm. O'Neil & Sons Co., 502 N. Central, Faribault, Minn., awarded contract for paving 25 miles near Burlington, at $537,000 (Kane County).

Ia., Davenport—McCarthy Impvt. Co., 802 Kahl Bldg., Davenport, contract for paving in Winnebago, Ogle and Lee Counties, Illinois, at $720,000.

Ia., Marion—Wm. Horrabin Co., 15 E. College, Iowa City, contract for 12.75 miles Lincoln Hwy. F. A. P. 96, Sec. A, hwy. W, from Cedar Rapids to Benton Co. line; at $213,978; Sec. B, from seedling mile east to Cedar Co. line, $164,585.

La., Gretna—E. J. Deas, Inc., awarded contract for 20-ft. asph. rd. with concrete base and concrete drain system, to extend over Metairie Ridge to Shrewsbury, at $104,102.

Mass., Boston—C. Bianci & Co., Framingham, awarded contract by Dept. Pub. Wks. for bitum. macadam paving; 21,012 ft. hwy. in Fitchburg and Westminster; $211,840.

Mass., Boston—L. C. Carchia & Co., Bellevue St., West Roxbury, awarded contract for rein. conc. paving; 17,724 ft. highway in Lenox and Lee, at $202,000.

Mich., St. Joseph—W. J. Cleary, Benton Harbor, awarded contract by Berrien Co. Rd. Comn., for impvt. of Niles-Watervliet rd., at $55,400; also contract for South Park Rd., at $43,975. Niles-Watervliet Rd. will be slightly more than 3 miles long (no. & so. in Bainbridge Twp.); So. Park rd. approx. 2½ miles, Pipestone Twp.; Henry Schultz, contract for Snow extension rd. and Weesaw-Lake town-line rd., at $46,201 and $45,930, respectively.

Mo., St. Louis—Following contracts let by Board Public Service: Webb-Boone Paving Co., 5927 Fyler Ave. pavement, etc., Delmar Blvd., at $43,600; Trinidad Asphalt Mfg. Co., Title Guaranty Bldg., Elmbank St., at $17,906; Francis St., $18,643; Webb-Kunze Construction Co., 5927 Fyler Ave., Tenn St., at $13,280; Theodore St., $15,618, Bancroft St., $11,638, Montana St., $14,200, Garner St., $10,642; Central Paving & Constr. Co., 6161 Maple St., Fyler St., $34,304, St. Louis St., $43,992, Eyermann Constr. Co., 1216 S. Grand Blvd., Garner St., $22,711; Blackburn & Cuan, Chouteau Tr. Bldg., East Gate and Enright Aves., at $6,692.

Mo., Jefferson City—State Hwy. Dept. let contracts for 28 roads: Andrew Co., 2.936 miles 30-ft. graded earth rd. to T. J. Morris, Oregon, at $24,115; Lewis Co., 3.864 miles 16-ft. gravel surfacing to Firmin T. O'Dell, New London, at $46,562; Cedar Co., .936 miles 12-ft. gravel surf. to N. A. Christy, Warsaw, at $13,019; Clark Co., 3.995 miles 20-ft. gravel surf. to Frank Teack, Rensselaer, Ind.; Johnson Co., 4.898 mi. 30-ft. graded earth, to Gaines Bros. Co., Fairland, Okla., $42,488; Ozark Co., 2.596 miles 12-ft. gravel surf. to J. P. Harlin, West Plains, $9,847; Scott Co., 2.357 mi. 16-ft. gravel surf., McCann Bros. & Huffman, Grand Lawer, Ill., at $27,954; Shannon Co., 2.981 mi. 30-ft. graded earth, to Thomas & Johnson, Doniphan, at $31,225; Buchanan Co., 2 sects.—St. Jos. to Grayson—to Bryant Paving Co., Waterloo, Ia.; 4.711 mi. earthwk. $6,743; 4,711 mi. 16-ft. conc. surfacing at $57,017; Clinton Co. 8 sections—St. Jos. to Grayson—to Bryant Paving Co.; 3.975 mi. 18 ft. conc. surf'g. $43,475; 3.001 mi. earthwork; 3.001 mi. 18-ft. conc. surf., $33,615; 1.715 mi. earthwork; 1.715 mi. 18-ft. conc. surf., $18,657; 2.685 mi. earthwk; 2,685 mi. 18-ft. conc. surf. $28,488; Grundy Co., 2.423 mi. earthwk. to A. C. Johnson, Carrollton; 2 sections to Harrison Constr. Co., Des Moines, Iowa; 3.351 mi. earthwork; 3.351 miles 18-ft. conc. surf., at $70,674; Livingston Co., 2 secs.—3.454 mi. 30-ft. graded earth, to R. P. Harper Constr. Co., Leona, Kans., at $14,256; 4.032 mi. 30-ft. graded earth, to Pioneer Constr. Co., 101 N. Y. Life Bldg., Kans. City, at $31,577; Oregon Co., 3.92 mi. 30-ft. graded earth to J. P. Harlan, West Plains, at $42,088; 1.454 mi. 30-ft. graded earth to Summerfield-Jones Co., Billings, at $12,928; Polk Co., 2 sections: A. A. Davis & Co., Grain Exchange Bldg., Okla. City; 4.381 mi. 18-ft. gravel surf., $41,185; 2.197 mi. 12-ft. gravel surf., $20,925; Texas Co., 1.614 mi. 30-ft. graded earth from Mt. View no. and south, to A. A. Davis & Co., at $27,611.

Nev., Reno—I. Christiansen, 109 Sierra St., Los Angeles, awarded contract for impvt. of various streets, 85,000 sq. ft. conc. walks, 39,000 ft. 8-ft.-6-in. and 4,000 ft. 2-ft.-6-in. conc. curb and gutter, 3,200 ft. 8-in. and 500 ft. 6-in. conc. gutter, 15,000 sq. ft. concrete paving, at $93,765.

N. Y., Brooklyn—Borough Asphalt Co., 1301 Metropolitan Ave., contract for paving (asphalt) Gold and Ridgewood Avenues, at $26,485 and $47,709, respectively.

N. Y., Long Isl. City—W. H. Gheoghegan Realty Co., 147 Remsen St., Brooklyn, awarded contract for grading, etc., Beach Channel Dr. and constructing bulkheads, etc., at $509,115.

O., Ravenna—T. L. McCormic, Ravenna, awarded contract for impvt. of Diamond St., no. and so. of Main St., at $57,689.

Ore., Eugene—Following local firms received contracts for paving: Stein Bros. contract for Columbia St.—Franklin to Fairmount Blvd.—at $31,231.90; also contracts for Charnelton to Lincoln St., at $10,092 and 13th Ave.—Willamette to Charnelton St.—at$7,281; also 18th Ave. $12,000 and 17th Ave.—Willamette to Jefferson St.—at $21,759.80; Guy Pyle, contract for 19th Ave.—Wllamette to Lincoln St.—at $11,798.50.

S. C., Aiken—T. E. Hook, New Brookland, awarded contract by Aiken Co., sand-clay surfacing 7.7 miles State Rte. 12, State Proj. S-522-A, at $60,777.

S. C., Newberry—Southern Paving Constr. Co., Volunteer State Life Bldg., Chattanooga, awarded contract for 60,000 sq. yds. street paving, at $300,000.

Tenn., Nashville—Following contracts let by State Dept. Highways and Pub. Bldgs.: Grading & bitum. macad. surf. 8.56 mi. Woodbury-Warren Co., line rd., 16 ft. incldg. 2 brdgs over 20-ft. span. F. A. P. 48-A, Cannon Co., to W. N. & A. L. Elrod, Murfreesboro, at $266,223; 6.1 mi. Sequatchie Rd., 1 brdg. over 20-ft. span, Marion Co. to Carter Constr. Co., Chattanooga, at $153,540; grading and gravel surf. 7.57 mi. S. A. P. 187-A. Hardin Co. to Bearden & Scott, Iuka, Miss., at $128,298, 0.5 mi. Gainesboro-Roaring River Bridge Rd. 20-ft.

S. A. P. 135-C, Jackson Co. to H. H. Ruddell, Madisonville, Ky., at $16,695; grading, chat and gravel surf. 6.87 mi. Sorby-Hardin Co. line Rd. 16 ft. S. A. P. 186, Wayne Co. and grading and gravel surf. 19.03 mi. Decatur-Hamilton Co. line rd. 16 ft. S. A. P. 140-B, Meigs Co. to G. W. Guinn Co., Birmingham, Ala., at $101,964 and $61,064, respectively; grading, chat and gravel surf. 15.17 mi. Paris-Ky. State line Rd. S. A. P. 146-B, Henry Co. to S. E. Finley Co., 212 W. North Ave., Atlanta, Ga., at $101,761; grading, 6.95 miles Forbes-Kentucky St. Line rd. incldg. 2 timb. brdgs. over 20-ft. span, S. A. P. 188, Pickett Co. to Davis Constr. Co., Worthburg, at $65,064.

Tex., Boston—Contracts let as follows for 2 roads in Bowie County: (Over 16 miles)—State Hwy., 47, so. of Texarkana to McCartney Bridge on Sulphur River, to Tibbetts Construction Co., Ft. Worth, at $255,663; no. of Texarkana to Index bridge, across Red River, to Meyer & Greenwald Constr. Co., Meridian, Miss., at $203,329.

Tex., Sulphur Sprgs.—D. Ward, Itasca, awarded contract for grading, gravel surfacing and bridging 7.8 miles State Hwy. 1, State Aid Proj. 501-D, 16 ft. and 15.24 miles State Hwy. 11, 26 ft., at $48,704 and $65,629, respectively.

Tex., Waxahachie—Purvis & Lowry, Waxahachie, awarded contract to supply limestone base on 45 miles lateral rds. in Dist. 1, at $144,946.

Wis., La Crosse—T. E. Woolley, 148 West Ave. S., La Crosse, awarded contract for brick paving on State, Redfield, 6th, and other streets, at $132,541.

SEWERAGE AND SEWAGE TREATMENT

D. C., Washington—V. Harry Angle, awarded contract for interceptor sewer in Rock Creek Park, at $55,139.

Cal., Los Angeles—Leo Miletich, 610 W. 54th St., awarded contract for sewer in Meyler St., Sepulveda St. to 23 ft. so. of First St., at $16,400; Atkinson-Spicer Co., 921 Chapman Bldg., awarded contract by Board of Public Works for constr. of Sec. No. 1 of the Arroyo de la Secatella stone drain sys., in Country Club Dr., Burch Pl. to 3rd Ave., and portions of other streets, at $1,306,219. R. A. Watson, 1026 McCadden Pl., contract by Bd. Pub. Wks., for constr. of Sec. 25, No. Outfall sewer—west prolongnation of Sixth St., east of Los Angeles river and intersection of Enterprise Ave.—Santa Fe Ave., as follows: Type 2, Item (a) 4,837 ft., 5 ft. semi-elliptical conc. sewer, incl. curves, transitions, manhole, etc., at $74,500; item (b) 336 lin. ft. spcl. struc. (river crossing) incl. C. I. pipe, reinf. conc. pipe support, piers, footings, expansion joint, etc., at $12,000; Peter Reach, 518 New High St., contract for sewer in Compton Ave.—Shorb Ave. to Slauson and portions of other streets.

Cal., Ripon—W. J. Tobin, 527 Santa Ray Ave., Oakland, awarded contract by Ripon Sanitary Dist., for sewerage system, at $28,650.

Cal., Santa Barbara—Jas. T. Cornwall, 227 Equestrian St., Santa Barbara, awarded contract by City Mgr., Herbert Nunn, at $74,831 for constr. of Garden and Quinientos St. trunk sewer and the East Blvd. interceptor.

Cal., Santa Monica—Claude Fisher, 1682 4th St., Santa Monica, contract at $31,000 for vit. pipe in Georgina Ave.—26th St. to 21st Pl.—also portions of other streets.

Ont., Toronto—Contracts for vit. tile sewers in lanes at Roxborough and Yonge Sts., to National Contracting Co., 9 Garnock Ave., at $2,728; in Fitzroy Terrace to L. P. Acri, 102 Markham St., at $825; interceptor conc. trunk sewer in 3732 ft. Boulevard Dr. Secs. B and C, to Russell Constr. Co., Harbor Comn. Bldg., at $43,684.

Ct., Hamden—(New Haven, Postoffice)—C. W. Blakeslee & Son, Waverly Street, New Haven, awarded contract for 8-24 inch sewer tile, house connections and manholes in Whitneyville Sec., at $160,422.

Fla., Ft. Pierce—Morgan Hill Paving Co., Graham Bldg., Jacksonville, awarded contract for sewers, vit. clay pipe, at $265,000.

Fla., Sarasota—J. L. Walker Co., 231 Court St., Hamilton, Ohio, awarded contract for 3 complete san. sewerage systems; 49,300 ft. pipe in trenches, 6 to 8 ft. depth, at $65,000; remodeling 3 septic tanks, pump screens, 1 pumping station, 7,600 ft. 10 and 12 inch force mains, etc., to Erler Corp., Tampa, at $26,000.

Kans., Ft. Dodge—Carrothers Constr. Co., 310 Walsix Bldg., Kansas City, Mo., awarded contract by State Soldiers' Home, for 15,300 ft. 6-10 ft. vit. clay pipe, 9 manholes, 2 flush tanks, etc.; 2,800 ft. 2 and 6 in. cast iron pipe, 16 gate valves, etc., at $37,650.

Md., Baltimore—P. Marocco, 638 S. Linwood Ave., awarded contract by Bd. of Awards for 7,500 ft. 8 to 48 in. sewers in Storm Water Contract 80, at $59,319.

Md., Baltimore—Aiello Constr. Co., Gough & 4th Sts., awarded contract by Bd. of Awards, for 9,000 ft. 8-72 inch sewers in Dist. H-6, Contr. 70, at $75,411.

Mich., Pontiac—Walb Constr. Co., LaGrange, Ind., awarded contract for 1,500 ft. 36-in. brick and vit. trunk sewer from Mt. Clemens and Hill Sts., at $29,735.

Mich., Sturgis—Wolvering Engrg. Co., Mason, awarded contract for 2,080 ft. 54-in. tile segment blk. storm sewer and 1,850 ft. open ditch in So. Clay and Florence Streets, at $44,820.

Minn., St. Paul—H. Huebscher, 736 Hamilton Ave., awarded contract for sewer in Otto Ave., at $47,950.

N. Y., Long Isl. City—M. E. Connolly, Pres. Queens Boro, Queens Subway Bldg., awarded contracts for sewers in Queens Blvd., to J. Gallo, 203 Division St., Brooklyn, at $138,103; Laburnum Ave. to Kennedy & Smith, 93 Amity St., Flushing, at $168,793.

N. Y., New York—Anita Constr. Co., 2975 Marion Ave., contract for sewers in Wilcox Ave., at $27,-819; E. 233rd St., at $124,387; J. V. Timoney Constr. Co., 220 E. 201st St., Hobart Ave., at $2,790, E. 172nd St., $25,902, Cruger Ave., $5,185; Strang Ave., $1,770, Mace Ave., $19,563; Spadoro & Turriamo Co., 3185 E. Tremont Ave., Sands Pl., $3,710, Yates Ave., $36,830; Slack & Slack Corp., Fielo Ave., $30,468.

N. C., Siler City—J. B. McCrary & Co., Citizens & Southern Bank Bldg., Atlanta, Ga., awarded contract for water and sewer system. $750,000 bonds available. Spoon & Lewis, Engrs., Greensboro.

Ohio, Canton—Holmes Constr. Co., Wooster, awarded contract by City for sewage disposal plant addn., including 3 sets of sedimentation tanks, sprinkling filters, complete, 41,000 c. y. earth excav., etc., at $829,000.

Ore., Reedsport—Inland Constr. Co., Ry. Exchange Bldg., Portland, awarded contract by Council for sewerage system, at $39,347.

Tex., Mission—N. A. Saigh Co., San Antonio, awarded contract for constr. of sewerage system, at $34,967; H. J. Wilson, Pharr, at $21,000, for sewage disp. plant.

Tex., San Antonio—Elder & Walker Construction Co., awarded contract for san. sewers on No. Trinity St., at $28,000.

WATER SUPPLY AND PURIFICATION

D. C., Washington—Lock Joint Pipe Co., Ampere, New Jersey, awarded contract for pipe line, at $283,950.

Cal., Glendale—National Cast Iron Pipe Co., 1026 Matson Bldg., San Francisco, awarded contract by City, at approx. $61,036, for cast iron pipe.

Ga., Hapeville—Dysard Constr. Co., Atlanta, awarded contract for water works impvts. and extensions here, for which $45,000 bonds were recently voted.

Md., Baltimore—Bd. of Awards reported to have let following contracts for trench excavation for Water Dept.: M. L. Quinn, 5307 York Rd., at $28,-470 for No. and N. E. Dists.; W. I. & J. B. McHugh, 4105 Bellview Ave., at $76,850 for N. W. Dist.; P. G. Ligon, at $50,075 for Western and Southern Dists.. Board of Awards let contract for cast iron pipe and fittings to U. S. Cast Iron Pipe and Fdry., Burlington, N. J., at $162,600; 250,000 lbs. pig lead to N. Trotter Co., 36 N. Front St., Philadelphia, Pa., at $24,425; 150,000 lbs. lead substitute, to Leadite Co., 1512 Land Title Bldg., Phila., Pa., at $18,285.

Minn., Duluth—Following contracts for cast iron pipe and spcls. let: Pipe to Jas. B. Clow & Sons,

447 McKnight Bldg., Minneapolis, for 1,500 to 2,000 tons cast iron water and gas pipe, $109,850; spcls. to Thomsen Fdry. Co., 212 Garfield Ave., Duluth; 75,000 lbs. cast iron specials at $3,150.

Mo., St. Louis—Jas. McNeil & Brothers Co., Pittsburgh, Pa., awarded contract by City for 16 miles 60-in diam. steel pipe. Contract involved abt. 13,000 tons steel plates, the contract for plates being awarded by the McNeil & Bro. Co., to Carnegie Steel Co. The new supply line will be installed from Howard's Bend on Mo. River into City. This project, including purch. of pipe, also installation, est. to cost abt. $2,000,000. Contract also to B. Hayes, Inc., Detroit, Mich., for 83,000 ft. 60-in. steel pressure conduit and 3,000 ft. 48-in. pipe.

N. Y., New York—Beaver Eng. Co., 57 Chambers St., New York City, awarded contract for constr. of Sec. 1, Williamsburg Conduit, portion of city conduits Catskill Aqueduct, Contr. 219, at $1,010,000; Sec. 2, Brooklyn and Queens Boros. Contr. 218, to P. F. Connolly Co., Stapleton, at $1,597,121.

N. C., Highlands—Conrad Constr. Co., Florence, S. C., awarded contract for gravity water supply system, at $30,000.

O., Cincinnati—U. S. Cast Iron Pipe Co., Addston, awarded contr. by City for furnishing and delivering cast iron pipe, special castings, etc., during 1925, for water distribution system, at $46,305.

Okla., Wetumka—Conner Constr. Co., Rialto Bldg., Kansas City, Mo., awarded contract for new purification and power plants, basins; 4,900 ft. 6-10 in. cast iron pipe, 14 valves, 4 motor-driven pumps, two 400 hp. engines, etc., at $105,374.

Ore., Portland—U. S. Cast Iron Pipe & Fdry. Co., Colman Bldg., Seattle, awarded contract for 25,000 tons cast iron water pipe, at $126,160.

Pa., Philadelphia—J. J. McHugh, 1617 Race St., awarded contract No. 724, at $21,986; P. & A. Ellis, 5724 N. Marshall St., Contr. 732, at $427,680, by Dept. of Pub. Wks., Bureau of Water.

Pa., Phila.—M. J. McCrudden, 1134 Real Est., Trust Bldg., awarded contract, at $9,110, and M. & J. B. McHugh, 892 N. Markoe St., contract at $200,696 (Bureau of Water Contracts, Nos. 734 and 735).

Tex., Edinburg—Fairbanks-Morse & Co., Market St., Dallas, contract by Hidalgo Water Impvt. Dist., No. 4, for pumping plant, 2,000 hp. full Diesel engines and centrif. pumps to deliver 337.5 second ft., etc., in connection with irrigation project in Hidalgo Co., at $129,050.

Wn., Bellingham—U. S. Cast Iron Pipe Co., Birmingham, Ala., awarded contract by Water Board for cast iron pipe, at $38,164.

Wn., Port Angeles—Morse & Wiley, Seattle, Wash., awarded contract for gravity water supply, at $278,000, based on continuous wood stave pipe. Burns & McDonnell, Cons. Engrs., Kansas City and Los Angeles.

Wash., Seattle—Argentieri & Co., awarded contract providing for installation of water mains in West Marginal Way, at $65,317.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—City plans to expend $105,000 to pave 3 close-in streets and about $250,000 to pave other streets. A. J. Hawkins, City Engr.

Alaska, Fairbanks—Approval of rd. proj., estimated to cost $750,000 for Seward Peninsula in Alaska, voted by House in passage of Sutherland's resolution authorizing constr., under direction of Rd. Commrs. of territory in accord. with plans approved by the army engrs. Project calls for extension of Nome-Shelton tramway from Shelton to Dahl, 12 miles, $150,000; impvt. of winter trail to summer trail standard from Dahl to Immachuk, 65 mi., to cost $195,000; constr. of tramway from Immachuk to Candle Crk., 30 miles, $405,000. Territorial funds will be required to contribute 20 per cent of cost.

Cal., Alhambra—Bids will soon be asked for paving of Main St., and Valley Blvd., through City from east to west City limits. Pavement will be 6 ins. and cost $240,000. City Mgr., M. H. Irvine.

Cal., Los Angeles—Jno. J. Dillon, Chf. Engr., Greater Washington Blvd. Assn., and other associations for impvts. of highways betw. Los Angeles and the ocean, has announced that Wilshire Blvd., betw. Rimpau Ave., and City limits of Beverly Hills, is to be widened 200 ft.

Cal., Pomona—Bids will be called for in April for extension of Holt Ave., east and west through City to western City limits with concrete pavement; $58,000 of cost will be paid by County and the U. P. and S. P. Railways will each pay $24,000.

D. C., Washington—Dist. Commrs plan resurfacing 18 streets and paving 5 streets. C. B. Hunt, Engr. of Highways.

Fla., Bradenton—$1,400,000 bonds voted by Manatee County. Commissioners plan 7 paved, macadamized or other hard surf. roads. Bradenton-Arcadia, Parrish-Wauchula, Parrish-Polk Co., Bradenton-Palmetto bridge; Ellenton-Gillette, Rubonia Cutoff, Range line.

Fla., Dade City—Pasco County plans to improve 27 roads totaling 125 miles. Will vote in April on $1,300,000 bonds.

Fla., Davenport—City contemplates expendt. of $300,000 for paving streets.

Fla., Ft. Pierce—St. Lucie County, Vero District, plans 55 miles hard surf. roads here. Est. cost, $400,000. Contemplates bond issue.

Fla., Jacksonville—Duval Co. Commrs. plan to complete and improve highways in County. Considering $938,500 bond issue. C. S. Coe, County Engr.

Fla., Kissimee—City Commrs. plan to pave 37 streets, totaling 10 miles. Est. cost, $100,000. Plans sewer and water systems. Contemplate $152,000 bond issue.

Fla., Monticello—Jefferson County plans bldg. and maintaining rds. in County. Considering $1,000,000 bond issue.

Fla., New Smyrna—City plans 14 miles of street paving. $320,000 bonds voted.

Fla., Sanford—Seminole Co. plans road bldg.; contemplates $1,500,000 bond issue.

Ill., Decatur—Resolutions on four paving projects passed by City Council. They include 15 city blocks. Est. cost of projects, $86,000.

Ill., Kewanee—City contemplates paving impvt. which will cost more than $84,000. Includes W. Prospect St., So. Grove St., Franklin and 5th Aves., Additional paving proj. voted on at recent meeting of Bd. of Local Impvts., includes Burr, Elm, First and Lyle Sts. Est. cost, $42,547.

Ia., Des Moines—City Engr., Karl Kastberg, making plans for 250,000 sq. yds. paving. Ready for bids abt. May 1st. Abt. $750,000. City Clk., A. E. McGlothlen.

Ia., Logan—Will build road along rte. followed north of here by K. T. Approved by Board of Supvrs. Abt. $230,000. W. R. Adams, Co. Aud.

Ky., Owingsville—State Hwy. Comm., at Frankfort plans to let contract July 1st for 13-mile road betw. here and Farmers on Midland trail, Bath Co. Dan W. Doggett, Co. Atty.

Md., Baltimore—State Roads Commission, 601 Garrett Bldg., plans surfacing 70 miles in Southern Maryland, with crushed stone and oil. Jno. N. Mackall, Chrmn.

Md., Baltimore—City plans to improve 32 streets. Est. cost, $435,000; grade 4 streets, $40,000. Nathan L. Smith, Acting Chf. Engr. of Paving Comn., 214 E. Lexington St.

Minn., Worthington—Will take bids in April for graveling State Rd., 11, Job 2591, 5 miles on Nobles and Jackson Co. line; State Rd. 2, Job 2502; State Rd. 12, Job 2503, 5 miles connecting No. 2 and No. 7; State Rd. 14, Job 2504, 12 miles; State Rd. 1, Job 2505, through Linsmore Twp., State Rd. 15, Job 2506. Grading to be later on State Rd. 16, Job 2597 running so. 15 miles. C. J. Kail, Co. Aud.

Neb., Plattsmouth—Contemplate about 25 1-2 blocks of paving on N. 3rd, Oak, Locust, Elm, N. 11th, 8th, Elm, Pearl, Marble, 10th, Rock and 6th Sts. J. J. Cloidt.

Nev., Carson City—Following projects will soon be advertised: No. 66, 10.25 miles grav. surf., Westgate to Eastgate, Churchill Co.; 8.09 mi. gravel

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Kentucky Rock Asphalt Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Pierce-Arrow Motor Car Co.

Automobiles.
Ford Motor Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Brick, Paving.
National Paving Brick Mfrs. Assn.

Bridges.
Luten, Daniel B.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping
Littleford Brothers.
Pawling & Harnischfeger

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Gun Work.
Indiana Gunite & Const. Co.

Cement Testing.
Chicago Paving Laboratory.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chemists, Engineering
Chicago Paving Laboratory.
Dow & Smith.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Clay Pipe, Vitrified.
Clay Products Assn.

Clay Products.
Clay Products Assn.

Concrete Bridges.
Luten, Daniel B.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Rosing, Inc., Astrid S.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, Burdick & Howson.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Druar & Milinowski.
Flood, Walter H., & Co.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

surf., Humboldt Co., Winnemucca to Button Point, No. 82B; 9.7 mi. gravel surf., Humboldt Co., 8.5 miles east of Golconda to Stonehouse; 7.79 mi. gravel surf., Button Point to Golconda, Humboldt Co., No. 82D. Projects on which plans are complete: 10 miles, Lander Co., Battle Mtn., to 10 miles east, also 9.94 mi., 10 miles east Battle Mtn. to East Co. line; 10 and 20.5 miles Wells to Moor and Silver Zone to Wendover, respectively, Elko Co., Nos. 90D and 90C, 15.5 mi. Lincoln Co., Dutch John's to North Co. line—all gravel surf.; conc. and steel undergrade crossing struct., Humboldt Co.

Okla., Newkirk—Kay County will soon receive bids for grading 22 1-2 miles of road from Newkirk. Est. cost, $60,000.

Okla., Okla. City—State Highway Comn., Okla. City, will soon let contracts for bldg. hard surface roads and 5 bridges, including bridge over Arkansas River betw. Pawnee and Osages Counties. Est. cost, $4,215,000. E. B. Guthrey, Secy.

S. C., Columbia—City plans to lay gravel on about 50 blocks of streets. Sam H. Owen, Supt. of Streets.

Tenn., Dyersburg—Dyer Co. Commrs. plan 7 roads: Dyersburg to Lake Co. line; Dyersburg to Crockett Co. line; from Crockett Co. line to intersect. Jeff Davis Hwy.; Dyersburg to Lane's Ferry via. Millsfield; Tigertail; complete road from near Menglewood to Heloise. $1,000,000 bond issue available.

Tenn., Huntsville—F. W. Webster, Knoxville, Engr., Eastern District of Tennessee, preparing plans for section of Cincinnati-Lookout Mountain air line road in Scott Co.

Tenn., Union City—Obion Co. Commrs, plan hard surf. roads; contemplate $1,000,000 bond issue.

Tex., Austin—Travis County plans 9 miles 18-ft. bitum. macadam road on State Hwy., No. 20, Manor Rd. Est. cost, $278,000. O. Leonard, Co. Engr., Box 216. Geo. S. Matthews, Co. Judge.

Tex., Childress—City plans to pave 50 blocks of streets in residence section.

Tex., Corsicana—Navarro County plans to build 3 18-ft. conc. rds.; 102 miles. North and so. from Ellis Co. line through Rice, Corsicana and Richland to Freestone Co. line; east and west from Hill Co. line along Cotton Belt Ry., to Trinity River or Henderson Co. line, with 1.5 mile trestle; Hill Co. line to Corsicana. Considering voting on $3,500,000 bonds. W. W. McClendon, Engr.; Ballard W. George, Judge. City of Corsicana plans to pave 12 blocks of streets.

Tex., Dallas—City plans street impvts. Will vote April 7th on $250,000 bonds. Jno. C. Harris, Finance Commr.

Tex., Sherman—Grayson Co. considering county-wide road impvt. May vote on $4,500,000 bonds.

Va., Ft. Myer Hts.—Arlington Co., Arlington District, Good Roads Commission (Arthur Orr, Chrmn.) plans 20 miles road bldg., contemplates $753,503 bond election.

Va., Richmond—State Hwy. Commission, Richmond, plans 4 roads and bridge: Dinwiddie County, 2.25 miles conc. from Ritchie's Store west; Scott Co., 4.85 miles grading and draining from Scott-Lee Co. line to point east; Caroline Co., 3.02 miles soil roadway from pt. west of Rappahannock Academy to point west of Ware Creek; 4 miles conc. from Ritchie's Store toward Dinwiddie Courthouse; Rockbridge County bridge over Buffalo Creek; 3 miles so. of Lexington. Est. cost, $173,250. C. S. Mullen, Chf. Engr.

Wash., Kelso—S. A. Cobb, Location Engr. for State Hwy. Dept., estimates that relocation of Ocean Beach hwy., west of here betw. Coal Crk., and Cathlamet (16 miles) will cost $800,000 to grade and gravel.

W. Va., Huntington—Cabell County, Barboursville District, plans 12 miles lateral roads in Dist. Considering $200,000 bond issue.

W. Va., Wheeling—Ohio County Commrs. will receive bids in April or May to excavate and pave 4,000 ft. boulevard through Wheeling; concrete base, brick top, 30,000 sq. yds. earth and rock excav. A. C. Hoffman, Co. Rd. Engr.

Wis., Madison—Paving program of 1925 referred to St. Comn. for recommendations. Includes paving on about 20 streets. Est. cost, $265,127. F. E. Parker, City Engr.; H. C. Buser, City Clk.

SEWAGE AND SEWAGE TREATMENT

Ark., Foreman—City contemplates laying abt. 5 miles sewers (san.) Est. cost, $25,000. Engineer not yet selected. Mayor O. W. Gillerman. Dist. being organized.

Cal., Dos Palos—Bond election will be held in Dos Palos San. Dist., to vote on $30,000 issue for city sewer impvts., involving treatment plant on branch canal No. 2 (Imhoff tank with sprinkling filter sys. to serve 1,000), constr. of main outfall sewer system and lateral system. W. F. Bedeson, Merced, Cons. Engineer.

Cal., El Segundo—Koebig & Koebig, Title Ins. Bldg., Los Angeles, appointed consulting engineers to R. T. Hutchins, City Engr., for new sewer system. Amt. of bond issue and other details not yet determined. Same firm has also been appointed Cons. Engrs. on work at Monrovia. H. S. Gierlich, City Engineer.

Cal., Hermosa—$200,000 lateral sewer bonds voted here at recent election. This is in addition to $350,000 voted for main sewer.

Cal., Los Angeles—The $3,520,000 bond issue for sewer constr. in Sanitation District No. 2, under Metropolitan Sewer plan, carried at recent election. Dist. embraces Norwalk, Artesia, N. Belvdero, Bellflower, Cudahy, Downey, Clearwater and portions of Whittier Blvd. Albert K. Warren, Co. Sanitation & Draing. Engr., in charge of constr.

Cal., Patterson—City will expend approximately $30,000 for sewer in First St., to care for sewage from creameries and lbr. yds.

Cal., Patton—Walter D. Wagner, Director of State Institutions, announces that new sewage disp. plant will be built at Patton State Hosp.

Cal., Porterville—As soon as legally possible another $50,000 sewer bond issue will be submitted to Porterville voters. Impvts. have been ordered by State Board of Health.

Cal., Santa Barbara—Plans and specfs. practically complete for sewerage system to serve approx. 25 blocks. Proceedings will be ready for bds in about 60 days. Geo. D. Morrison, City Engr.

Cal., Venice—$325,000 bond voted for sewer system. Proposed system includes 24-in. line betw. Venice and Del Rey where it will connect with the L. A. outfall. H. D. Chapman, City Engr.

B. C., Vancouver—Sewer constr. at head of False Creek is to cost around $150,000. City Engr. has brought in a report to this effect. It is probable that in order to provide funds for sewer work it will be necessary to submit a bylaw to rate payers in June.

Fla., Bartow—City will probably vote in abt. 60 days on sewer bonds. W. Bradley, Clk.

Fla., Titusville—City will vote on $400,000 bonds, including sewers, parks, etc.

Ill., Belleville—Definite decision made to sponsor plan which embraces new intercepting sewer, new septic tank and straightening and widening Richland Creek with bldg. of necessary bridges.

Ill., Carterville—Will receive bids in May for complete san. sewerage system, including disposal plant, etc. Caldwell Engrg. Co., 502 Ayres Bldg., Jacksonville, Cons. Engrs. Est. cost of impvt., $150,000.

Ill., Deerfield—Plans being made for East Side and Northwest Side sewerage systems, $100,000 and $55,000, respectively. Cons. Engrs., Consoer, Older & Quinlan, Marquette Bldg., 140 S. Dearborn St., Chicago.

Ill., Jonesboro—Soon to take bids on 8 to 10 in. sewers in various streets and disposal plant. Est. cost, $40,000. W. A. Fuller Co., 1917 Ry. Exch. Bldg., St. Louis, Mo., Cons. Engrs.

Ill., St. Elmo—Prelim. plans being prepared for disp. plant, sewer extensions, etc. $66,000. Caldwell Engrg. Co., 502 Ayres Bank Bldg., Jacksonville, Engrs.

Ia., Boone—Construction of disposal plant contemplated. Engrs., Burns & McDonnell Engrg. Co., Kansas City, Mo., preparing plans. Abt. $75,000.

Ia., Centerville—City considering addition to sewage disposal plant. Merton G. Hall, Engr. Abt. $40,000. E. A. Crane, City Clk.

Ia., Council Bluffs—City considering storm sewer project to cost abt. $110,000. Jno. F. McGeeney, City Clk.

Ia., Ft. Dodge—Will construct approx. 5 miles

BUYERS' GUIDE

Deep Well Pumps.
Harris Air Pump Co.
Keystone Driller Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Dryers.
Cummer & Son, The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Machinery.
Westinghouse Electric & Mfg. Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Excavating Machinery.
Austin Machinery Corp.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co., Inc.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Gates, Sluice.
Coldwell-Wilcox Co.

Graders.
Austin-Western Road Machinery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gunite.
Indiana Gunite & Const. Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Mead-Morrison Mfg. Co.

Hot Mixers.
Austin Machinery Corp.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corp.
Koehring Co.
T. L. Smith Co.

Motor Fire Apparatus.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Duplex Truck Co.
Federal Motor Truck Co.
Ford Motor Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers, and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Murpysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

sewers in SE sec. of City. C. H. Reynolds, City Engr., C. W. Wickham, City Clk.

Mass., Boston—City contemplates extension and impvt of sewerage systems in city at cost of $1,500,000 or more. F. H. Fay, City Planning Bd. Chrmn.

Mass., Woburn—City and Metropolitan Dist. Comn., Boston, plan trunk line sewer through the Aberjona Valley; $300,000. J. R. Rabin, Metropolitan Dist. Comn., 1 Ashburton Pl., Boston, Engr.

Minn., Albert Lea—W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Ia., engineers for preparation of plans for sewage disposal plant. Water Works Mgr., Robt. Anderson.

Minn., White Bear Lake—Constr. of sewerage system here being considered. Engineer not yet selected. Dale Merrick, Mgr.

N. D., Fargo—Will probably lay trunk sewer with 48 in. main in No. Fargo this summer. If approved by Commission plans will be made and bids taken. City Engr., R. T. Jacobsen. A. R. Watkins, City Clerk.

Okla., Pittsburg—City will soon receive bids for sanitary sewers; $270,000. Gantt, Baker & Co., Engrs., First National Bank Bldg., Okla. City, Okla.

S. C. Honea Path—City has voted $48,000 bonds for sewer system.

Tex., Crowell—City voted $50,000 bonds. For additional detailed information, address Mayor.

Tex., Dallas—Election April 7th on $250,000 sewer, $250,000 san. sewers, $650,000 park bonds. Jno. C. Harris, Finance Commr.

Va., Portsmouth—Council has authorized issuance of $150,000 sewer and $30,000 incinerator bonds. J. P. Jervey, Mgr.

W. Va., Huntington—City will vote on $1,000,000 sewer bonds, etc. Floyd S. Chapman, Mayor.

Wash., Seattle—Construction of sewer system, costing approx. $100,000, to cover Pioneer and Modern addition in northwest section of Yakima, will be undertaken this spring. System will be built of vit. clay pipe.

Wis., Sturgeon Bay—Engineer authorized to make plans for laying sewer and water extensions in Garland St. loop. E. Odbert, Engr., Edw. S. Ackerman, City Clk.

WATER SUPPLY AND PURIFICATION

Ark., Brinkley—Ark. Light & Power Company (H. C. Couch, Pres., Pine Bluff), reported to erect $50,000 water plant.

Ark., Greenwood—City will probably install $75,000 water and sewerage system.

Cal., Los Angeles—Application made by Dept. of Pub. Service, Bur. of Water Wks. & Supply, Los Angeles, to construct 16-in. water pipe across (under) Cerritos Channel west of Badger Ave., bascule brdg., Long Beach, at depth of 42 ft. below mean lower low water. Map showing location of struct. will be on exhibition in office of U. S. Engr., 725 Central Bldg., H. A. Finch, Major, Corps. of Engrs., Dist. Engr.

Cal., Los Angeles—$1,300,000 water bond issue of Laurel Canyon Water District carried at recent election. System will include mains and reservoirs to deliver water to 1,450 ft. elevation, or 600 ft. higher than at present.

Cal., Manteca—City Council will engage an engineer to prepare plans and estimates for city water system.

Cal., Needles—Plans being made for new water works to involve reservoir, mains and other impvts., involving about $150,000. Burns & McDonnell Engrg. Co., Los Angeles, Cal., Cons. Engrs.

Cal., Newport Beach—City trustees have instructed City Atty. to prepare resolution requesting $350,000 bond issue for enlarging and extending domestic water system here.

Cal., Van Nuys—City Council has been studying revised map of Laurel Canyon impvt. district which plans $1,300,000 bond issue for installation of a distribution system in that section of State that will be linked with Van Nuys municipal aqueduct system.

Colo., Lakewood—Ctiy has adopted City Engineer Strong's plans for water works impvts. Est. cost about $476,000.

D. C., Washington—Water Works Dept. will request $1,020,000 for program of impvts. Expenditure of $175,000 planned for service main extension and $23,000 for hydrants.

Fla., Miami—City (F. H. Wharton, Mgr. voted $250,000 water and $400,000 park bonds; also $100,000 city's share of sanitary sewers.

Fla., Pablo Beach—Ctiy plans to vote on $350,000 water and sewer bonds.

Fla., St. Petersburg—City Commission has approved definite plan to increase water supply here (unlimited supply capable of caring for city and whole of the Pinellas peninsula. New proj. will probably involve well supply and call for installation of softening equipt.

Fla., Tampa—C. V. Starkey Development Co., Lafayette street, will soon begin installation of water supply in Two Pines subdiv.; will also construct roads and streets.

Fla., Winter Garden—City has selected J. B. McCrary Engrg. Co., Atlanta, Ga., as engineers for municipal impvts., including additional water mains, san. sewer extensions, lake front harbor which provides for fill for one-half mile in length, with blvd. bordering on lake 300 ft. wide and 11-acre park.

Ga., Atlanta—City Council has authorized expenditure of $50,000 for water works for girls' high school, Federal penitentiary.

Ga., Atlanta—Water Works Committee of City Council will have plans prepared by Paul Norcross, Candler Bldg., for $2,500,000 water supply and power plant. Construct dam across Chattahoochee River.

Ill., Chester—Election planned here to vote on $42,000 bonds. It is thought that $10,000 may be used to purchase present water wks. sys., $25,000 for installation of filtration plant and $7,000 for construction of steel tank with 100,000 gals. capy.

Ill., Chicago—Plans prepared and filed with Dept. of Pub. Wks. for new pumping plant to cost about $2,500,000.

Ill., Highland—A new water works system is to be installed here at cost of about $175,000; will include a 10-mile sewer district as part of 1925 program.

Ill., Lebanon—Plans being made for distribution system, deep wells, pumping equipt., tank on tower, etc. Est. cost $50,000. Caldwell Engrg. Co., 502 Ayers Bank Bldg., Jacksonville, Engrs.

Ill., Newton—Bids for constr. of water works, including filtration plant, will be called about June by city. Plans prepared by Caldwell Engrg. Co., Jacksonville, Ill.

Ind., Columbus—Expenditures totaling several thousand dollars for water works impvts., necessary for reduced fire insurance rates, according to Inspection Bureau's report. Impvts. would involve increasing size of mains generally from 4 to 6 inches, installing hydrants and removing dead ends.

Iowa, Ames—City Engr. P. F. Hopkins, making plans for approx. 3 miles water main extensions to be ready for bids about April 1. Est. cost $35,000. A. B. Maxwell, City Clk.

Ia., Ft. Dodge—City will construct several blocks of water mains. C. H. Reynolds, City Engr. C. W. Wickham, City Clk.

Ia., Tama—Will probably receive bids in spring for extension of water mains and constr. of a 200,000 gal. elev. tank. Engrs. Chas. L. Pillsbury Co., 1200 2nd Ave., S. Minneapolis, Minn. D. A. Murdough, City Clk. Est. cost about $40,000.

La., Donaldsonville—Plans and specfs. being prepared by J. W. Billingsley, Cons. Engr., Interstate Bldg., New Orleans, La., for filtration plant here. Impvts. will include tower, tank, settling tanks, reservoir and electrically driven pumps. Bids for general contract will be called for about April 1.

La., Lake Charles—Lake Charles Elec. Co., Inc., contemplates installing 1,000,000 gal. reservoir; will construct several miles water mains.

Mass., Brookline—A $400,000 bond issue voted for purpose of connecting town's water supply with Boston Met. Dist. water system.

Mass., Fitchburg—City threatened with water shortage and Commr. David A. Hartwell, of Pub. Wks., is petitioning Council for establishment of additional large reservoir.

Miss., Hazlehurst—City will vote on $75,000 water and light bonds.

BUYERS' GUIDE

Pumps.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.

Rock Asphalt.
Kentucky Rock Asphalt Co.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Scarifiers.
Austin-Western Road Machinery Co., The

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Clay Products Assn.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Sewer Pipe Joint Compound.
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Dallmann Machine & Mfg. Co.
Good Roads Machinery Co., Inc.

Special Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin-Western Road Machinery Co., The

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Keystone Driller Co.

Steel Joists, Studs and Sash.
Truscon Steel Co.

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Lighting.
Holophane Glass Co.
Westinghouse Electric & Mfg. Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch.
The Barrett Co.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Best Tractor Co., C. L.
Ford Motor Co.
Holt Mfg. Co., Inc.

Transmission, Truck.
Warford Corp.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck.
The Hug Co.

Valves.
Coldwell-Wilcox Co.

Vitrified Clay Pipe.
Clay Products Assn.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.
Stewart, W. H.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Carey Co., Philip.
Pioneer Asphalt Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.

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—Mixers, Hot
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—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
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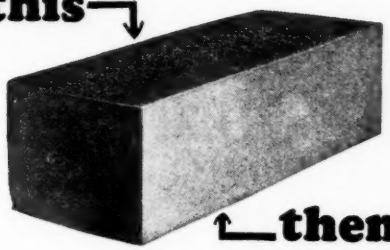

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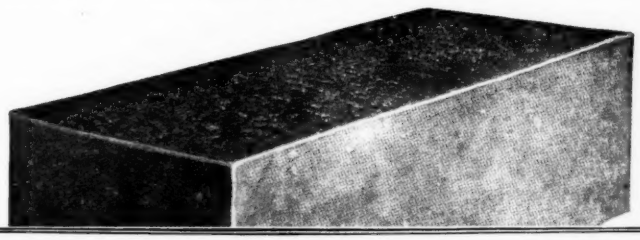

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—Condensers
—Conduit Rods
—Cranes, Locomotive
—Cranes, Traveling
—Curb Boxes
—Curb Cocks
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—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
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—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
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—Filter Equipment
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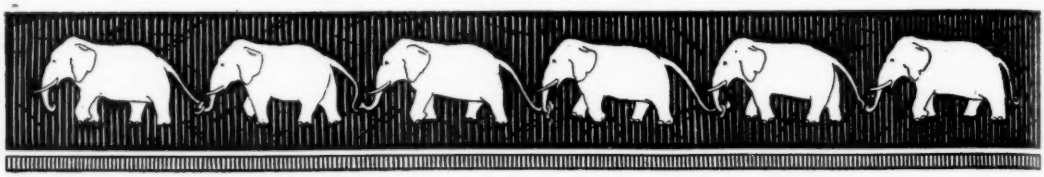

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The fact that more than half of all the trucks in operation in the United States are "light" trucks, that 78 per cent of these are Ford trucks is evidence of the passing of the "heavy" truck.

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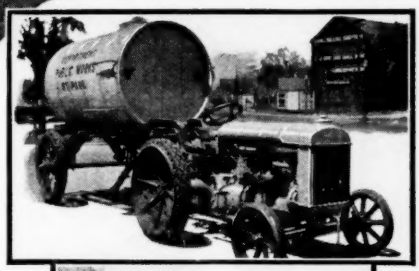

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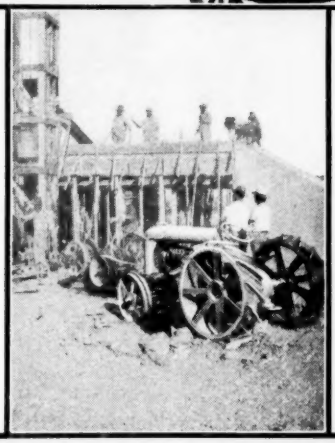

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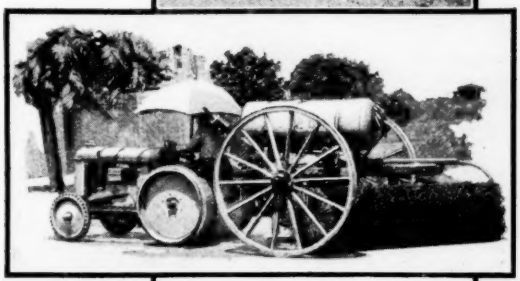

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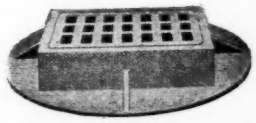

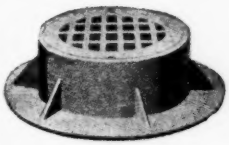
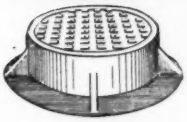
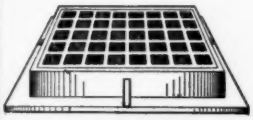
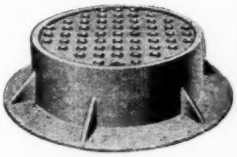

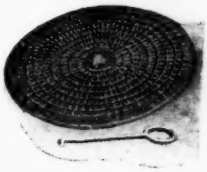

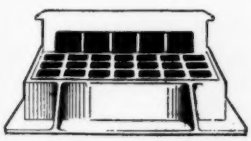
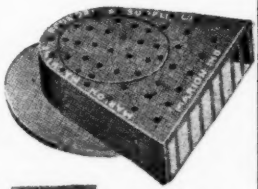
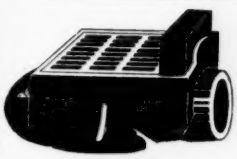
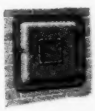
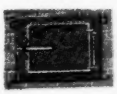

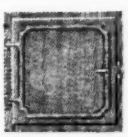

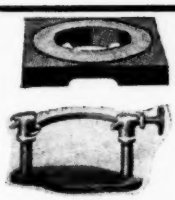
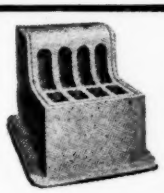

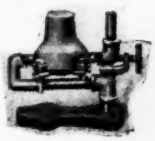

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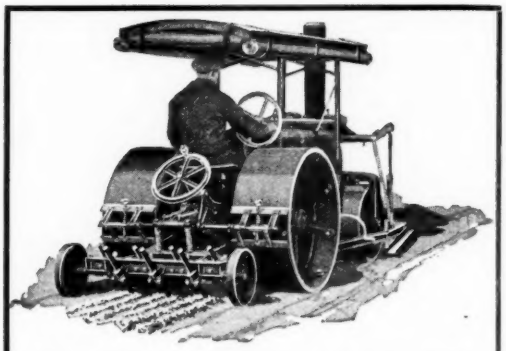

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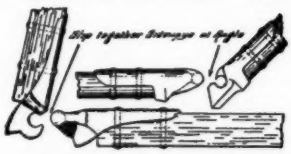

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TAKING SOME OF THE GUESS OUT OF BIDDING

By S. J. Clausen of Cameron, Joyce & Co., Contractors, 17 S. 7th St., Keokuk, Iowa.

(Editor's Note: The following constructive paper was read by Mr. Clausen at a meeting of the Illinois Association of Highway and Municipal Contractors at Urbana in February of this year. The highway department to which reference is made is, of course, the Illinois State Highway Department.)

This paper embodies the views of Cameron, Joyce & Company, the members of this organization having contributed their experience to its preparation. In other words our company has taken this opportunity to express our views seriously because we consider your invitation to speak here as an expression of your confidence,—your confidence that our suggestions will be made in good faith and in a spirit of true co-operation. We, therefore, thank you for this opportunity and enthusiastically hope that these remarks and the subsequent discussion will be of material value in taking the guess, or some of the guess, out of bidding. I say, some of the guess; let us not become too perfect and take all the guess out. When that millenium arrives we can imagine Mr. Sheets opening the bids and announcing: "All the bidders on Section 436 bid the sum of 90506 dollars and 2/3 of a cent." So perhaps it would be well to retain some of the uncertainties in bidding, such for example, as the weather—especially the good weather, petitioning the department in this connection only for a longer Indian summer. And let us not ask the State to reimburse us because gasoline has gone up, or because oats did not get cheaper as we thought they would.

Our suggestions then will be confined to practices of contractors and the highway department in the award and execution of work, wherein we believe there is room for modification to mutual benefit.

The Contractor's Inspection of the Work

Now as to the contractor. The first step is thoroughly to inspect the work on which a bid is contemplated. This inspection is of utmost importance in taking the guess out of bidding, and the task of making it should never be delegated to any but the most experienced and competent men in the organization. The side track, water, nature of materials, in the subgrade, labor conditions, source and availability of materials, railroad service, etc., will all receive consideration in this inspection and these conditions will all influence the contractor in making up his unit prices.

Figuring the Work

In actually figuring the work, our plan is to have before us, a previously prepared memorandum, for a slab job, of all the elements that enter into the pavement. This is to eliminate the chance of overlooking any item of cost. The following are the elements we consider in figuring a job of this kind: Cost per cubic yard of coarse aggregate, fine aggregate, handling cement, water, mixing and storing materials. After reducing these costs per cubic yard to cost per square yard, we add these items per square yard: Cost of steel, subgrading, forms, rolling, wetting and covering, curing, stakes and helper, liability, demurrage, shoulders, depreciation, overhead, bond and profit. Having this memorandum before us we then take into account such conditions as labor, railroad facilities, location of work and general conditions which tend to make the job more or less desirable for our particular organization. As one instance, we take into account whether materials are delivered from the producer over one or several railroads, since this is a factor in obtaining uniform shipments. We then proceed with the actual figuring.

Cost Data Misleading

Here I wish to call your attention to one element of cost which is not an element of cost; namely, cost data. To figure one job on the basis of what a former job cost means simply that the contractor gambles he can perform a certain operation under one set of conditions at the same price for which he did perform a similar operation under different conditions. We call this practice "copying bids." Cost data are valuable to an engineer. They are valuable in making up estimates. But we fear there are many contractors who attach too much importance to them. It is sure that we take costs into account. Every contractor must. But we only do so to the extent which these data help to make up the sum and total of our experience and judgment. We often go to a letting with a goodly bunch of papers, but among them all there is not a single sheet of cost data.

Evils of Competitor Domination

We proceed then with the figures and carry them up to the point where we are

ready to write them into the bidding blank. It is at this fatal moment the figurer usually decides he is tired and needs to take a little stroll through the lobby. Here the human element enters. He finds the hotel lobby seething with a host of competitors and if he does not hold himself in perfect control his bid is in the hands of the fates. All too often he grows too panicky, rushes to his room and begins to whittle. In the resultant confusion he does not know or seem to care whether he has any profits left in the work. Contractors as a class, while not mathematicians, are all good at figuring. But sometimes in the presence of menacing competition they have been known to throw their figures away and bid on the dictates of intuition, snap judgment, or heaven knows what. They themselves do not know after the letting is over. We admit we do a little guessing on competition, sometimes a whole lot of it. But we always do so with our original figures before us. We want to impress this upon the contractors here; base your bid on what the work will cost, not on competition. You can figure work correctly, and you know you can, but you can't guess what the other man will bid, and if you stop to think about it, you know you can't. I believe the great mindreaders of the vaudeville circuits would be soon out of a job if they were to choose Illinois contractors for their subjects.

Bidding on Performance of Untried Machinery

The subject of equipment does not come under this head except indirectly. There are now machines on the market to perform almost every operation in road building and new ones being constantly introduced. The contractor who intends to buy some of this equipment sometimes basis his bid on the savings he anticipates this machinery will make. This is a fatal mistake. We do not advise too much equipment; we believe over-equipment has been the ruination of many contractors; but go ahead and buy the machine if you so elect, but do not bid on its performance until it has already performed and in your own outfit.

What the Engineers Can Do

Now, what can the engineers do to take the guess out of bidding? Our first suggestion relates to the first step in roadbuilding; that is the surveys and plans. These are often too hurriedly gotten out. We appreciate that conditions exist which often make a hastily gotten up set of plans seemingly unavoidable. However, the unforeseen expense caused to contractors by the modification of plans is incalculable. These changes a contractor cannot foresee. He should not be expected to foresee them. He must bid on the plans, and must organize his work by those plans and then when there are changes made, a veritable monkey wrench is thrown into the machinery of his organization. Here is the source of most of the bickering, the arguments, the bad feeling. Here is the cause of many of the trips to headquarters for redress. I want to give you a few examples of the results of changes in plans.

Bad Results of Changes in Plans

First consider culvert work. A contractor's first step on a job is often to send in his plans to a steel company with an order for all the steel shown. Soon after he commences work, the engineer discovers errors. This culvert is too short, that one too small and the next one not needed at all. Then small quantities of steel are ordered for quick shipment. Delays start, and so does ill-will. Later on, after the grading is well under way, it develops that an additional culvert is necessary. This may seem a small thing when compared to the job as a whole, but it is a serious thing to the culvert gang, and to its profits; and in the end, what is a road job, but a series of small operations?

On Bridge Work

The character of the bottom, the depth of the digging, and the necessity and length of piles very largely determine the character of this work. I regret to say the bridge builder must guess at all three of these controlling elements. He must do exactly as the engineer did. In other words, the preliminary soundings and survey are not accurate enough to justify the engineer in definitely stating the character of material, the exact depth of footing or the length—or indeed the necessity of piles. Until such time as the Department investigates bridge sites more thoroughly, we believe it should be more liberal in reimbursing the contractor for losses caused by changes in the footing depth, steel and piling, as well as delays made unavoidable in reordering these materials, and expense of moving pile driving equipment to the job when piling later is deemed unnecessary.

On Grading Work

Here the preeminent example of guess work is borrow pits. When the borrow pits are not shown, it is guess work. When they are shown, it is still guess work. Sometimes the right of way is not secured, sometimes they are too wet to work; sometimes drainage is not provided for; sometimes they are inadequate in size. There is nearly always something wrong with borrow pits. We cannot doubt that these troubles are all due to the original plans. Enough care and time are not taken to investigate, survey and procure borrow pits before the work is let. A great deal of money has been left buried by grading contractors in these unsuitable borrow pits and chiefly through no fault of theirs.

For example, a job with some low borrow is let in the fall. The contractor moves immediately on the job to do this borrow at that favorable time of the year, but the right of way deal has not been closed, and he cannot move on it until spring, when like as not, it is too wet to work. Again, a contractor is working away on a nice piece of borrow. When he has reached a pretty good depth it is found that the pit will not furnish enough of material. Widening is not practical, deepening is impossible. The engineer hastens to do what he can to obtain more borrow, but it is too late. Nothing he can do now can fully reimburse the contractor for his disrupted plans and delay.

Aggravating Small Items

The small items, such as guard rail and entrance culverts, are often a source of aggravation due to incomplete plans. Often final acceptance of work has long been delayed because of our inability to find out how much guard rail or how many entrance culverts were required until the job was nearly done. We are sure that the engineers are capable of visualizing the needs for guard rail and culverts before the slab and shoulders are ready for them to ride over. These items also include drainage ditches, slope walls, crossroad approaches, etc. It seems that the details could be planned out long in advance of completion of the slab work.

We are not presenting these items in the nature of a reflection on the Department or its personnel. We have a very high regard for the highway organization of this State, and we must admit that your plans are well up to the standard, and indeed above the standard of many other States, but we do believe there is room for improvement in the work along this line, in this State, as there is elsewhere.

Therefore, we make this plea to the State. It will cost a lot of money. It will take more men and more time to get them out, but its cost will be small compared to the annual loss of contractors due to this one cause.

Securing Right of Way in Time

Plans naturally bring to mind the subject of right-of-way. Contractors have the right to expect the right-of-way will be procured. Too often this is not the case. This is another element of guessing. We believe right-of-way should be gotten before the letting and in the few cases where this cannot be, more ginger should be put behind the efforts to secure it ahead of the contractor's needs. There has been a lot of what we cannot help calling procrastination in this regard. We feel the State has not at various times given due weight to the importance of prompt action in securing right-of-way. We have at times had to go to the landowners ourselves to close right-of-way deals for the state, and we know some other contractors have had the same experience. So we feel justified in asking the State to give this matter more careful attention.

Items to Bid On

I will now bring up the subject of items to be bid on, because we feel it belongs in this discussion.

There seems to be a tendency in this department to simplify the bidding and estimates by reducing and consolidating the units bid upon. We are not at all in accord with this tendency, on the ground that it gives rise to a lot of guess work in bidding. When shoulders were included with the slab work, it was said this would save the State money, because some contractors would forget to figure the shoulders. We know the State would not adopt any policy on such grounds, and we also affirm that a low bid in which the shoulders were forgotten is not the lowest responsible bid,—in the truest meaning of the phrase. We do not believe more units will have any tendency to raise prices but we do insist they will make the bids more sane and reliable.

In the drainage structures, we feel that culvert work and bridge work are two distinct classes and that the units in these classes should be bid upon separately.

We feel that temporary bridges should not be thrown in with the bridgework. They should either be paid for as extra work or plans prepared and a chance given to bid on them. As it is, we can only guess whether the engineer will require an elaborate structure or only a couple of plank covered logs.

We favor having the item of shoulders put back in the bidding. This for the reason that shoulders are as distinct an item and as clear cut a unit in our opinion as a yard of dirt or a square of slab.

We endorse this State's adoption of three classes of excavation and believe it will reduce a lot of guess work in bidding. We take the liberty to suggest for your consideration a fourth class,—namely, wet excavation. There are wet cuts and dry cuts in Illinois, but the best grading man can never be sure what a cut is until he gets into it. If he assumes it is wet, he won't get a job. If he thinks it is dry, he may wish he didn't have a job. After the experience of last season I fear a good many contractors will assume all cuts are wet. We feel the State will save money by including this item, besides putting the bidding on a sounder basis.

We would like to see a unit price for clearing and a unit price for grubbing. Under the present plan, changes of location often work a hardship on the contractor.

Overhaul should not only be shown on the plans but paid for at a unit price.

Stakes and Helper

I wish now to mention one item that is always a sore spot to the contractor. That is, the item of stakes and helper. No one can guess what this item will cost. Some engineers have been very considerate of the contractor's money in this regard. Others have not. But regardless of this, the system is uneconomic and unsatisfactory both to the contractor and to the engineer. Some times the engineer requests one of your best workers. As the duties of helper are not very strenuous this man soon gets spoiled for honest work and always has his eye open to get back to the engineer. And, if we pick up someone to help the engineer, it does not look fair to our other men, who have to work, for this person to be on the same payroll with them. In the smaller organizations, such as culvert work and grading, the loss of a man a few hours a day is a constant source of disorganization. These outfits cannot afford to hire a man simply to help the engineer. It seems that every time we are short handed and hard pressed to get a piece of work done, here comes the engineer down the road for a man. We would surely be gladder to see him and would get along better with him, were it not for this stake and helper nuisance. We, therefore, ask that we be relieved of this burden.

We believe the reduction of units has had the effect of injecting more guesses into bidding. After doing a lot of work in one State and one locality, a contractor learns what these hidden units amount to, and bids accordingly. But it is unfair for him to have to meet the competition of newcomers who are unfamiliar with what these uncertain and unexplained items will cost. And after this newcomer gets the work there is always unpleasant friction when the engineer points out a lot of work to be done for which there is no extra compensation.

After the contractor has completed his job, he has one big guess yet to make. When will the job be accepted? Many contractors have been put to unnecessary expense in the matter of final inspection. We suggest that the decision of the man who goes over the work for this inspection should be final. As it is at present, some one from the Department goes over the work and finds a few clogs and weeds which he wants removed, and drives away without accepting it. Later on, sometimes weeks later, a different man comes out and his eyes see a few other items of little or no importance. Acceptance is thus sometimes delayed until it has become a serious matter to the contractor who, in the meantime, has been maintaining this road, and is constantly being put to expense for this or that little item suggested by the inspectors. No man can serve two masters and no contractor can please two inspectors. We should know who has authority to make final inspection and that man should accept the work when it is done. In case of a few minor things to be done he can instruct the Resident Engineer that when these things are completed the work is accepted. This scheme has often been followed and to the satisfaction of everyone, but it is not the invariable rule by any means.

This concludes our suggestions for taking the guess out of contracting; we hope they will provoke a little discussion and that you will give them whatever consideration they deserve.

OBJECTIVES IN SEWAGE TREATMENT

By Jack J. Hinman, Jr., Associate Professor of Sanitation, University of Iowa, Iowa City, and Chief, Water Laboratory Division, Iowa State Board of Health

There are two general objectives in sewage treatment. One has to do with the actual improvement, to a desired point, of the physical, chemical and bacterial state of the waste-bearing liquids discharged into a stream, while the other is a legal objective having to do with the avoidance of damage suits, injunctions, and similar impediments to the use of the body of water for the purposes of the individual, corporation or community in question. To a certain extent these two objectives are related. That is, in order that the legal objective may be gained, a certain, more loosely-defined and generally less definitely-understood objective is established for the quality of the effluent from the sewer. The quality of effluent usually desired is that quality, and unfortunately often just that quality, which will be sufficient to avoid trouble with farmers, communities and others interested in the condition of the stream below the point of entrance of the sewage.

The community that has installed a sewage-treatment plant on its own community initiative, without urging through official and legal channels, is a most unusual community; and an industry that has, without official and legal urging, put in a treatment plant for improving its wastes (unless it saw that it could make some money by so doing) is a most unusual industry. Community and industrial altruism cannot be relied upon unless it is cheaper to be altruistic. This is not to be considered at all surprising, because effective sewage-treatment plants are only to be secured at a price of installation and upkeep that makes them a serious demand on the city or industrial treasury. But damage suits, legal battles, and injunction suits can be just as expensive or more so; and so, given sufficient legal pressure, the plants are usually built. In some cases the mere possession and more-or-less effective operation of the plant is satisfactory to the people down stream. Frequently they have just as strong, though unsupported, confidence in the operation of the plant as the proprietors of the installation.

In cases where the burden imposed on the stream is heavy, or where those farther down have definite ideas as to what should be accomplished, and then proceed to satisfy themselves that the effluent measures up to the requirements, the objective of satisfactory plant operation may receive a much more definite meaning than otherwise. In order to ascertain what may be reasonable demands upon a plant and a reasonable sort of objective to be striven towards, it is worth while to ask what causes the trouble and why this trouble comes about.

Objections to Water Pollution

Most of the objections to the addition of wastes to streams and bodies of water may be ascribed to one or more of the following situations:

1. First and foremost, the nuisance of objectionable odors arising from the stream and commonly associated with the decomposition of sulphur-containing organic matters.
2. The possibility of contamination of water supplies, or of putting too great a burden upon water-purification apparatus.
3. The possibility of the stream being rendered more dangerous as a source of water supply for cattle and other domestic animals.
4. The killing of fish and the interference with the safe and pleasant use of the stream for swimming and boating.
5. Various poorly-defined health hazards.

Objectionable Odors

The objectionable odors that arise from decomposing matters of any sort are so insistently brought to the attention of persons in their vicinity that they have probably been responsible for more sewage-treatment projects than any of the other objectionable characteristics of sewage accumulations. Odors are phenomena which do not require the services of the expert to detect. Any one with a normal sense of smell can tell whether an odor is being given off by the effluent from a sewage plant or from the stream into which wastes have been poured. But all persons do not agree as to what constitutes an offensive odor, or as to the point at which an odor just ceases to be objectionable.

It is the usual experience that liquids which contain sufficient oxygen for their complete decomposition pass through that decomposition with much less offensive evolution of odors than those liquids in which the oxygen is deficient in amount. In general, there are two ways of providing an ample amount of oxygen. One

way is to limit the amount of sewage to a small percentage of the stream flow, trusting to the oxygen coming down with the water of the stream to provide for the decomposition of the sewage. The other way is to remove as much of the solid material as possible from the sewage, so that it may not accumulate in banks of sludge, poor in oxygen, from which foul odors arise. Then the liquids of the sewage should be put through some sort of equipment which is designed to hurry up the oxidation of the organic matter and to provide the amount of oxygen necessary for the work. The separated sludge is digested or rotted in special basins, while the effluent from the treatment of the sewage liquids is run away to the stream, having had a large part of its necessary oxidation effected, and bearing with it some additional dissolved oxygen. The first one of these processes is the well-known dilution process, while the process described with more detail is the outline of almost any of the systems of sewage treatment.

Along with the production of foul odors usually go objectionable scums, sludge banks, and blackening of the liquid or of the stream. Each of these may be considered a part of the same process of decomposition. As a rule, whatever will avoid the bad smells will get rid of the objectionable appearances; but it is the odor that is most objected to.

Contamination of Water Supplies

Danger to water-purification plants exists wherever a water-supply is taken from a sewage-polluted stream. It is probable, so long as the concentration of the sewage is not too great and the water-purification equipment works as it should, that there is little danger. But water-purification plants do not always work perfectly, and we do not know with exactness what constitutes an unreasonable load upon the purification devices. We do know that the farther upstream the source of contamination, the less the danger, since the dangerous bacteria tend to die off in competition with the natural bacterial inhabitants of the stream. We are convinced that the less the amount of sewage, the less the number of these pathogenic bacteria and the less the possibility that some of them, passing down the stream, may get by the artificial barriers of our purification devices. But no stream is safe to use for drinking purposes unless it brings water from uninhabited regions where there is no possibility of human contamination, either by hunters or campers, or by more permanent population. Certainly no stream water in Iowa is safe to use in the untreated state.

In the past it has been thought more satisfactory to throw the burden of final purification of the water on the water plant than to hold the sewage plant responsible for the production of a safe drinking water from the wastes which come from the sewers in concentrated form. The most that we have a moral right to demand from the operation of a sewage-treatment plant is that it shall leave the water of the stream no worse than it was above the outfall. Then, if we are not satisfied with the water of the stream, we must begin our purification program nearer the source and clean up the stream as we go down. In this way we may raise the standard of quality which we may reasonably demand of any treatment plant until the stream is brought within the necessary or desired range of purity. It is foolish to ask that the effluent of the sewage-treatment plant shall be treated to such a degree of refinement that it might be said that the effluent was polluted by the stream water. Moreover, although it is possible to secure such a degree of purity, it is expensive both as regards cost of equipment and as regards operation charges.

Some years ago, the International Joint Commission on Boundary Waters asked some well-known experts to give them a standard by which to judge whether or not a water was so polluted that a water-purification plant could not be expected to handle it satisfactorily at all times. The standard prepared by the experts demanded that the proposed raw water should not contain organisms of the Bacterium coli group in more than 50 per cent of the 0.1 c.c. samples of untreated water examined. There are plants, however, which are regularly operating on raw waters worse than the standard would allow and yet are giving acceptable results. In general, however, the treatment in these water plants is supervised by experienced men who are aided in their work by close laboratory control of the plant. We have some water plants in Iowa which are so operated; but the small plant is usually unable to secure this type of supervision. Moreover, the equipment of the small installation is sometimes far from as complete and as well thought out as it should be.

Thus the greatest danger from heavily-polluted water is met in the small plants when they are so located that they must handle highly-contaminated raw water. Thus, while sewage treatment is advantageous in any case, the treatment of sewage becomes more imperative when a water-treatment plant of the small, less-accurately-operated type is down stream. At the present time small water-purification plants in Iowa derive their waters chiefly from the impounded run-off of agricultural lands, but unless the writer is mistaken, the future will see a number of small water-purification plants installed of necessity on some Iowa streams that even now receive sewage and town drainage. Even though there be sewage-treatment plants provided, their work will be rougher in its nature than that of the water purification; and the treatment of the water will be the final safeguard against infection. It is in the water-purification plant that the removal and destruction of bacteria of all sorts is most satisfactorily accomplished.

Bacteria in Sewage Treatment

Many people think of a sewage-treatment plant as being primarily for the purpose of killing bacteria. It certainly is true that in the operation of a well-conducted sewage plant the bacteria in the effluent will be found much lower in number than in the raw sewage; but at some intermediate stage in the treatment the bacteria will frequently be found in larger numbers than in the raw sewage.

The sewage-treatment plant may be thought of as providing a sort of bacterial banquet. All sorts of bacteria come, and those that are able to do so, gorge themselves and multiply abundantly. After a time the food is nearly consumed, then the bacterial revelers die off due to the unfavorable effect of a diminishing food supply, aided, perhaps, by the accumulation of toxic wastes. Sewage-treatment plants are primarily destroyers of bacterial food, in that they foster the temporary growth of bacteria that eat the food. Then, by the destruction of the food, they limit somewhat the numbers of the bacteria that survive the process. Sedimentation and absorption mechanically remove many of the organisms. Certainly the delicate pathogenic organisms that are so dependent on just the right sort of food and just the right temperature may be expected to be the heaviest sufferers in the scramble for food that follows the bacterial Saturnalia.

The conversion of the organic matter in the sewage, by the agency of the bacteria and related organisms, changes part of it into a form usable by the green algae. If the effluent is allowed to collect into ponds, or still bodies of water, it may be covered in a short space of time by a mantle of these green plant forms, or scums. In their normal growth these plants give off oxygen, which is a useful thing, for the oxygen helps out further decomposition and provides for the needs of fish. Unfortunately, some of the green algae, such as oscillatoria, have odors of their own which may prove objectionable to those who live in the vicinity. In this way a sewage effluent which is perfectly stable may cause a nuisance to occur.

Draining the effluent away to a stream will prevent difficulties of this type, as scattering the growth of the algae down the stream will reduce any odors to negligible amounts. Copper sulphate may also be used to kill off the algae. It should be used as early as possible after the first appearance of the algae, so that a large volume of dead and decaying vegetation will not be left. Ordinarily, a very small dosage of the copper-sulphate crystals is all that is needed; but there are some forms of algae that will survive any reasonable dose. Fish are sensitive to copper and the sensitiveness differs with the species; care must be taken not to add enough copper sulphate to kill the sort of fish that exist in the stream. Algae are often troublesome in water-works reservoirs, because of the odors and tastes that they impart to the stored water. They are combated in water-works reservoirs with copper sulphate, and aeration is sometimes resorted to in order to dissipate the odors.

Substances present in the sewage may themselves possess powerful taste-producing properties, either as they come from the sewers or after combination with some such substance as chlorine, which is so frequently used in modern methods of water treatment. Compounds of the latter sort are the phenols related to carbolic acid, or to phenols which come from gashouse wastes and from the decomposition of certain organic substances. When treated with chlorine, these phenols form substitution products, called chlorphenols, which can produce objectionable medicine-like tastes in astonishing dilutions.

Pollution of Drinking Water for Animals

The matter of a proper sort of drinking water for animals is worth careful consid-

eration. Certainly the best water for animals is water that would be accepted as entirely suited for human consumption. The animals do not get that kind of water from surface ponds and brooks. I should like to learn something really definite about this subject from some worker in the field of veterinary medicine who had studied the matter of water supply for domestic animals as the matter has been studied in the case of water supplied to the population of cities.

Time after time samples of stream water—usually stream water that has received sewage pollution—are sent to the Water Laboratory Division of the Laboratories for the Iowa State Board of Health, and we are asked to say whether or not the sample of water is safe for the use of cattle. Usually the owner of the cattle is concerned about the matter. Sometimes he says that his cattle are not doing well, or that he has lost one or more head of stock. The matter has not been studied as an epidemiological study of an outbreak of typhoid fever is studied. All that is available is a mass of opinion from which it is hard to sift out the facts. The owner is worried and has vague notions about mysterious poisons in the sewage or sewage-treatment plant effluent.

I am not as much impressed by the mysterious poison as I am impressed by the fact that it is possible for disease to be transmitted to the animal from human or animal sources. The causative agents of these disorders are pathogenic bacteria, eggs and larvae of worms, flukes and other organisms that are parasitic, filterable viruses, and possibly other matters as well. It is difficult to feel sure in one's own mind as to the point where a water becomes unfit for animals. We have been holding that a water becomes unfit for cattle at that point where it is possible to note a definite difference between a normal stream water of the region and the water under examination. However, it is not always easy to say just what is characteristic of a normal stream water of the particular region, and we are not certain that the criterion thus tentatively established may not sometimes be too lenient, and at other times too strict.

The farmer is justified, of course, in demanding that his cattle shall not be endangered by water flowing onto and through his land, but has he not the right also to demand a certain factor of safety in the quality of the water? It would be decidedly advantageous to know how to come reasonably close to an appreciation of what is necessary. The town has a right to legal protection if its sewage-treatment plant is giving ample sanitary protection, and the farmer also has his right to be assured of the protection of his live stock.

In Iowa, where a number of towns of considerable size (such as Newton and Grinnell) are forced by their location to discharge all of the town sewage into small creeks which flow for some distance across agricultural land before receiving dilution in a stream of size, the matter of protecting cattle is very important. Such streams as these towns use are nearly dry in summer; adequate dilution is not possible.

A riparian owner is generally considered to have the right to have a stream flow through or past his land with its quality unimpaired and its quantity undiminished, except in such manner and to such extent as may result from a reasonable use by the proprietors of the land above him. It has generally been considered that the riparian owner had no recourse for incidental contamination of a stream by the cattle belonging to an owner far up stream, unless such herd was so large that the wastes were very considerable in amount. Recent experiments by Dr. Schroeder, of the Government experiment station at Bethesda, Maryland, have shown that bovine tuberculosis could be transmitted from a herd of infected cattle, pastured in a field on a stream, to a herd of tuberculosis-free cattle, kept in a lower pasture several yards away and out of sight of the first field. This fact may later give the courts a chance to determine if the reasonable use of a field includes the pasturing of tuberculosis cattle or cattle which have not been found to be free from bovine tuberculosis; but it has been held that pasturing cattle even above a water supply for a city, constitutets a reasonable use.

Stream Pollution Versus Recreation

Just now there is a great deal of useful propaganda being put out on the subject of stream protection by the sportsmen's organizations. They are in favor of cleaning up our streams, with the idea of returning them, as is said, to the condition in which the first pioneers found them. The sportsmen's organizations are primarily interested in the fishing, boating and swimming in the natural

bodies of water, and in securing safe, pleasant and beautiful places for recreation. But they are not blind to the other advantages of the program they are forwarding. Their chief interest, however, lies in preserving, or restoring, if need be, the heritage of the children in the America of the outdoors.

The economics of the situation is hard to measure, and it ought not to be taken too much into account. The fish which are taken from a small stream are probably not often worth as food supply what it would cost the state and government to propagate and distribute the young fish, or what it would cost city, state and industrial agencies to keep the contamination of the stream within reasonable limits at all times. The protection of the "old swimmin' hole" below the city sewers would probably cost enough to provide each boy who wishes to use it with a ticket to an elaborate natatorium and leave enough, over and above the expense, to make a fairly reasonable sum. To be sure, it has been decided that the use of the stream for dumping city sewage, aside from storm water run-off, may not be a reasonable use of a stream. The same has been held to be the case with industrial wastes. It would seem that the riparian owner could interpose objection to the stream pollution under his common-law rights and could insist upon the protection of the stream sufficient to allow fish to live and multiply in it. In spite of the fact that swimmers run certain risks of infection when bathing in sewage-laden waters, it might be hard for a riparian owner to obtain relief from this danger. It would depend upon what would be considered a reasonable use.

The writer, for one, is willing to subscribe to the doctrine that the community owes it to its citizens—and especially to its future citizens—to preserve the beautiful natural bodies of water and to keep them in such condition that they may be freely, safely and joyously used for recreation.

Other Hazards of Water Pollution

By ill-defined health hazards, in the list given above, are meant the sorts of health hazards that are often talked about quite glibly, but with a very hazy idea about what they really are or why the water of the stream is to be blamed for the condition. The most plausible of these health hazards are based on the breeding of flies and the carrying of infectious material to food by the agency of the flies; the infection of fish by parasites, such as various Asiatic flukes, which might cause disease in man were the fish eaten raw; contamination of milk from the soiling of bodies of cattle that had stood in a polluted stream; and the occasional contamination of wells by the overflowing of polluted water during floods. Possibly the nausea associated with the irritating psychical effect of odors should be included here, but the odors themselves are a nuisance.

None of these is of the same degree of importance, as a disease-causing matter, as is the contamination of public water-supplies or of water-supplies for animals, or the danger of typhoid and similar diseases caused by bathing in water containing fresh sewage.

It has been noted, however, that the thing which causes the most public indignation and which has resulted in the construction of the largest number of purification plants for sewage and industrial wastes, is not, strictly speaking, a health matter at all. It is the nuisance of the objectionable odors of decomposition.

As knowledge in the matter of waste disposal becomes more widely diffused this matter of the nuisance of odors will probably be less responsible for new construction. This will not be because the public will object less to the odors of decomposition. They will object more. They will, however, already have secured relief from much of this annoyance, and will be interested more in the adequacy of the protection afforded by the equipment. Just now, if a sewage-disposal plant exists, it is probably giving results satisfactory to the town (provided there is no water-supply plant taking water from the stream), if odors are avoided and enough dissolved oxygen is in the effluent so that fish in the stream receiving the discharge are apparently not affected.

Better Plant Operation Needed

More rigid demands upon the operation of sewage-treatment plants are certainly in prospect. Not much longer will the haphazard operation of small sewage plants be tolerated. The demands of the public are steadily growing more and more definite and, if the objective of avoiding legal controversy is the one which appeals to those in responsible charge of the affairs of a community, then adequate methods of disposal of wastes of all sorts will need to be in-

stalled and operated in an efficient manner.

Purification of community and industrial wastes must eventually be undertaken in almost all communities. Rational handling of the equipment must then follow.

The foregoing paper by Prof. Hinman was presented at the Sixth Conference on Sewage Treatment at Ames, Iowa, October, 1924.

RECENT DEVELOPMENTS IN BLASTING

By J. R. St. Clair, Sales Representative of Mesabi Range for Hercules Powder Co.

The most interesting developments in blasting history in recent years are, I believe, the following: Fire resisting powder; slow freezing dynamites which are practically non-freeze; improved blasting machines; light weight wrappings for gelatin; Hercoblasting.

A natural development in the explosive's business has been the production of a dynamite to replace black powder for certain work. There are two main reasons why this has been possible: First, there was a demand for a less dangerous explosive; and second, it has been demonstrated that in some ground the new powders are more satisfactory. In this talk when I speak of the new powders, I will class all those on the market together and for brevity call them special powders.

Let us look at these two points for a moment.

Safety of New Powders

The greater safety of the new powders is very easily illustrated. I have here a small quantity of black powder and a similar amount of what is known as special No. 2. The black is extremely sensitive to heat, while the special needs a prolonged application to even make it charr. You can see what a potential danger black is whenever the charging of holes is required near an operating shovel or locomotive. A spark dropping into a hole being charged with black is almost certain to cause it to shoot, whereas, the same spark falling in the special would probably be extinguished before any harm was done, or else set it afire, whereupon the smoke would give sufficient warning for the man to retire to a place of safety. These new powders called fire resisting, generally speaking, will all burn if sufficient heat is applied, while only a small spark is required to make "black" shoot. I think nothing further is needed to illustrate the point of safety. These new powders are made to detonate by the use of blasting caps, usually inserted in a stick of dynamite for a primer.

Characteristics of Black and Special Powders

That the special powders are better than black for a great deal of work on the Mesabi has been ably demonstrated. A comparison of the speed of the two will make clear the reason for this. I say "speed," because the word "detonation" cannot properly be applied to "black" any more than "burning" describes the explosive action of the specials. Black powder "burns" at the rate of 1,500 ft. per second while the average rate of detonation of the specials is about 4,500 ft. per second. The specials, then, have a "speed" about three times as great as that of black. This greater speed shows up very distinctly in shooting a bank. The "black" will turn up the surface and throw down the face a great deal more than the "specials." The action of an explosion as you all know is equal in all directions despite the fact that most old miners will tell you that dynamite acts downward and black powder upward. The old miner saw the difference in action, and only was mixed in his reasons. The whole point is that of speed. The energy stored in the specials is released so much faster than that in black, that more of it is dissipated before the bank starts to move upward, and so necessarily must spread. This leaves less energy for turning up the surface. The black on the other hand exerts much less of its energy before the bank begins to move. Then, quite naturally, the remainder of the gas will follow the path of lease resistance and push the surface of the shot higher in the air. We say that black "throws" more than special.

The reasons why the specials are more satisfactory for some work are easily seen. A large percentage of the Mesabi Range practice is to lay the loading track near the bottom of the bank before the shot is made. Now, if any delay occurs because the track is covered it's a very expensive procedure. The faster powders throw less and so cause less delay from buried track. This point applies to any ground.

Perhaps the greatest advantage of the

specials is shown where rock is to be shot. There are two prime necessities in shooting rock: First, the bottom must be broken, down to or below grade; second, the chunks must be small enough to pass through the dipper. This is more important in rock than in ore, where the bottom may sometimes be dug without proper shooting. For the second point let us return to our old miner. You might, if you were a good talker, convince him that explosive force was exerted equally in all directions, and that enough black had the same equivalent strength as 40 per cent dynamite, but you would never even get to first base by telling him that black could be used for "bull-dozing." This brings us again to the factor of speed. To break rock you have to hit it a smashing blow not just give it a "push."

Fast Powders for Rock Work

The faster powders, then, are those to use for all rock work. I venture to say that 75 per cent of the banks shot on the Mesabi can best be shot by the faster powders. Not that 75 per cent are rock banks. If they were, we would need more help than dynamite to break them for we would have no mines. However, many ore banks are pretty tight and need a shattering blow to make them dig easily.

We have become so accustomed to the use of dynamite at sub-zero temperatures without the bother of thawing it, that we forget the time we carried kettles of hot water around. The discovery of low freezing compounds has eliminated thaw kettles. I had quite a time finding one of these so you see how completely the low freezing powders have replaced the old. This section of the United States has probably as severe temperatures as any and the results obtained with even the small size cartridges are entirely satisfactory. They have been a real economy in time and labor, but perhaps their greatest usefulness has been in eliminating another potential danger. Cases were known where an impatient miner thawed dynamite on an iron shovel over an open fire. Many have lived to tell of it, a few have not. Of course, such practices are practically unknown now, due to the educational work of the various safety departments of the mining companies.

Improved Blasting Machines

The following is condensed somewhat from an article in the Explosives Engineer for March, 1923:

During the World War the blasting machines then on the market proved unsatisfactory, because of too many failures. The ordnance department in consultation with the electrical companies, designed and produced in quantities an entirely new type of machine. Some of the interesting uses the army had for blasting machines were: For shooting large ereas, for demolition of bridges, trenches, and dugouts. Blasting machines were also used for firing mortars which projected gas bombs over enemy territory. The mortars were placed in front trenches and fired from the rear, when the wind would carry the fumes toward the enemy. If there were any failures in firing them they remained in the open, where shrapnel or shells could afterward set off the bombs. This might occur at a time when the wind was blowing in an opposite direction, and so would act as a boomerang. Therefore, it was very necessary for no failures to occur.

One of the principal advantages of the new machine is in the generator. Practically all of the old types consisted of a short circuited, series-wound motor, in which a heavy current is built up during the stroke. At the end of the stroke, the short circuit is opened, which allows the field discharge from the generator to pass into the cap circuit. This is where the old type of machine is deficient, because almost the entire energy of the operator is consumed uselessly in the machine itself. The field discharge, which does useful work in the cap circuit, represents only a small percentage of the energy delivered by the man operating the machine. The relatively small amount and the short duration of the current which enters the cap circuit is usually responsible for the failure to fire all the caps. The new machine, on the other hand, has a shunt-wound generator. All of the energy of the operator is accumulated as the rack bar descends. The switch remains open until the stroke is nearly ended. At the instant of maximum amperage and voltage, current enters the cap circuit and this current is sustained for a considerably longer period than in the old type.

Tests made at the U. S. Bureau of Standards at Washington show that even a moderate current sustained for 1/5 second is much more effective than one many times higher, but which is sustained only 1/1000 of a second. Because the new machine utilizes all the energy of the operator and because the current it delivers

is sustained for a longer period, it has proved a much more efficient machine than previous types.

Careful tests made by the Bureau show that the small current (9/10 amp.) delivered by the old type machine was responsible for the failures that occurred when they were used. The new type delivers 1½ amp. at 300 V. when connected to a circuit of 1,000 blasting caps in series and the current is correspondingly greater when fewer caps are used. The superiority of the new machine is therefore apparent.

This brings to my mind a source of failure in actual practice which is seldom met with, that of leakage of current through the insulation on the ordinary E. B. cap wires. There are ores on the Misabe which are very excellent conductors, especially if they are wet. The result of shooting in one case was that 2/3 of the total caps in series shot, the number being about equally divided between those nearest the blasting machine on either side of the hook-up. The current had left the series and jumped across, leaving those caps at the end of the loop unexploded.

The conductivity of this ore was shown by the following test: A box of ore was taken from the mine and in it immersed two polished copper plates with copper wires soldered to them. When tested with the galvonometer a deflection equal to a resistance of about 75 caps on the rheostat was obtained. When the ore was further moistened and the plates allowed to remain in it for several hours, a much better deflection was obtained.

Ten Hercules E. B. caps were then buried in a box of ore and the ore was thoroughly wet. The caps were all connected in series, excepting in the center where a break in the circuit was allowed, the terminals in each case extending out of the box so there would be no chance of a short circuit due to contact at the connections. At first only a very slight deflection could be obtained on the galvanometer when the furthest terminals were tried. After about four hours the deflection was quite pronounced and equivalent to about 75 on the rheostat. The break in the circuit in the center was then buried in the ore without connecting but had the terminals of the break from ¼ to ½ in. apart. The distant terminals were then connected with the blasting machine and all caps fired. This showed distinctly the ground was highly conductive and that the regular insulation on the cap wires does not offer sufficient protection to allow satisfactory performance in wet ground, which is highly conductive, when the battery is used at its full capacity.

Light Weight Wrapping for Gelatin

Gelatin dynamite has been in use for many years and usually is popular with the miners on account of its plasticity, density and comparative freedom from obnoxious fumes. I might say that the nitroglycerin in gelatin is the same as that in dynamite except for the addition of a small per cent of gem cotton. This addition changes the nitroglycerin from a liquid to a jelly-like substance, hence its name. The water resisting qualities of gelatin are well known.

In an effort to improve still further the fumes of this powder the paper wrapper has been altered. The paper and its coating of paraffin give off a large percentage of the obnoxious fumes when detonation takes place. The paraffin in this case is by far the worse offender. In some cases the change has been to use an impregnation of paraffin and an inert clay filler. In this case there is a special impregnation of paraffin during the process of manufacture of the paper. In all cases there is no loose paraffin present.

This has given a gelatin which, when properly detonated, forms the minimum of obnoxious fumes obtained from any commercial explosive of today.

Hercoblasting

One of the most interesting blasting developments in the use of black powder is known as "Hercoblasting." This is a patented practice whereby the volume of gas produced by a black powder explosion can be generated in a much shorter time. Like most useful ideas it is very simple, and is merely the use of Cordeau Bickford fuse as the detonator in deep well drill holes with the black powder loaded around it. Cordeau Bickford is a small lead tube filled with T N T. For convenience in handling it is put up on spools of approximately 500 ft. It comes either plain or countered for protection while loading and tamping. T N T, while a very violent explosive when detonated, is the safest of them all. The proof of this is the fact that the express companies will accept this cordeau without any more special packing than a spool of wire. It requires a severe shock such as a No. 8 cap or a stick of dynamite to start it going, but when it travels at the rate of 17,000 ft. per second, which is

some speed when you consider that 40 per cent dynamite has only a rate of 12,500 ft. per second.

Hercoblasting is applicable only to shots made in column loads. A large percentage of quarry blasting is in deep well drill holes, sometimes with a depth of 100 ft. Most limestone quarries use these deep holes and have as their object as little secondary blasting as possible. The blast then must break the stone to a size easily handled. The speed of black powder alone is hardly great enough to give the shattering effect, but its initial cost is less than most of the dynamite which would serve the purpose. Hercoblasting solved this problem.

We shoot our column of black powder with this detonating fuse, and this is what happens. The flame of the detonating fuse is transmitted from one end of the column to the other at the rate of 17,000 ft. per second rather than at 1,500 ft. per second, or the rate of the black powder itself if ignited at one end only by the usual blasting cap. The same amount of energy is liberated in much less time and as a result the rock is broken much finer. This has been proven successful in most of the quarry work where such well drill holes are used.

This cordeau, by the way, is used at one mine on the Mesabi for all primary blasting because of its safety. In pocket shooting, of course, there would be no other object.

The foregoing paper by Mr. St. Clair was read at the meeting of the Engineers' Club of Northern Minnesota, at Hibbing, on January 10, 1925.

DU PAGE COUNTY (ILL.) BOULEVARDS

At a recent meeting of the board of supervisors of DuPage County, Illinois, the County Superintendent of Highways, E. L. Gates, explained a plan which he thought should be considered at this time. This is the securing of a wide right-of-way, at least 198 ft. in width, across the county, an approximate distance of 20 miles, in both the southern and northern sections, so as to take care of traffic in future years. The pavement to be constructed on these roads is not necessarily to be built immediately, but planned for and gradually worked out in the years to come.

The board of supervisors voted unanimously to adopt this plan, and in order to keep it separate from the other road plans, such as State Aid, Bond Issue, Township, etc., it was voted to call it the "Gates Plan," and to have a special committee appointed to promote it.

Chicago and other large cities are spending millions of dollars to widen streets, and if DuPage County, which lies immediately west of Chicago, can look ahead 10 years it will save a large amount of money that would then have to be used for buying right-of-way and will probably save, by buying at the present time, enough money to more than pay for paving this road when the time comes.

It will not be many years before DuPage County will be subdivided from Chicago on the east to Aurora and Elgin on the west.

It is the intention of the Board of Supervisors to make these wide roads boulevards and keep heavy trucks off them so that the traveling public will have a little pleasure when they wish to take a ride. Instead of having roads with ugly billboards, roadhouses and peanut-stands, it is the intention to beautify these roads with trees, shrubs and lights and, just as far as possible, keep out any objectionable features that now mar most of our roads.

The Chicago papers exaggerated the idea and said the country would have a bond issue immediately to improve these roads. This is a mistake, as it is not the intention, at the present time, to have a bond issue, but rather to complete roads now planned and simply secure the right-of-way for these two roads and let their improvement follow later.

A plan was suggested by Assistant Supervisor Glen Mount, of Winfield township, to divide the wide strip in the center of the road into sections and lease them to large advertisers for enough to pay for the road. This plan is meeting with a good deal of favor and as the advertising will be confined to shrubs and flowers, it will be an interesting and pretty drive, as well as a new feature in advertising.

Mr. Lies, chairman of the Board of Supervisors, was made chairman and empowered to appoint a committee to act with him in selecting the routes and to make plans for the future development of this great movement. This committee will include representatives from Cook and Kane Counties so that DuPage officials can cooperate with them in estab-

lishing the best routes and take care of the traffic which must pass through DuPage County from the west towards Chicago.

GRAVEL ROAD CONSTRUCTION IN MISSOURI

(Editor's Note: Following is the text of the Missouri State Highway Department Short Course Discussion for all employes on gravel road construction. B. H. Piepmeier is chief engineer of the Department.)

The Missouri road law specifies that the minimum type of surfacing to be constructed on the state system shall be equivalent to a 12-ft. gravel road. Gravel construction is generally used on what we may term our secondary routes. This does not mean, however, that we should in any way neglect or disregard details of constructing this type of surfacing. More attention should be given to the minor details of gravel road construction and maintenance, so that this type of road may render its maximum service to the traveling public.

A gravel road for certain locations and classes of traffic, will serve the public just as well and, in many cases, more economically than concrete, or some other high type pavement will serve other communities which have a more dense traffic and where the soil conditions are not so suitable for gravel road construction. In many sections of Missouri gravel roads can be built and maintained much more economically than other types of surfacing.

Need for More Care on Construction

In the past, gravel roads have generally been built by merely dumping material promiscuously upon the road, no thought being given to the gradation or uniformity of the material and the preparation of the subgrade. Many gravel roads have been built with excessive crown which, in many instances, forces the traffic to the center; this results in deep ruts and, in many cases, a large amount of material being whipped off or displaced on the shoulders and in the side ditches. When building a concrete or other high type pavement, the roadbed and subgrade are very carefully prepared, also each individual batch of concrete is carefully proportioned to see that the necessary materials enter the road to insure uniformity. If the same care were taken in the building of the subgrade and roadbed, and the selecting of materials with respect to uniformity in the construction of many of our gravel roads, a much better road would result and also less dissatisfaction with gravel construction.

Two General Methods of Construction

There are two general methods of constructing gravel roads, namely, the trench method of construction and the feather-edge method of construction. A careful study of the roads that have been built throughout the country to date, indicates that about half of them have been built according to the feather-edge method and the other half the trench method. There is considerable argument in behalf of both types. The type to be followed is usually governed by the soil and maintenance conditions. In general, it may be said that if the entire road is to be built in one operation, it is necessary to follow the trench method, otherwise a large amount of the gravel would be displaced or pushed off into the ditches and the crown of the roadway would soon become excessive.

Feather-Edge Construction

When it is possible to build a gravel road by what is termed stage construction, or by building it up in small layers at different periods, the feather-edge method is much more desirable. The tendency in gravel road construction is to follow the feather-edge method and to build up the surface by successive layers of from 2 to 4 ins., allowing each layer to become thoroughly compacted under traffic for from 6 months to 2 years before the succeeding layer is applied.

A road that has been properly graded and drained, can be very materially improved by the addition of but a small amount of surfacing gravel. The application of but a few inches of gravel will, on many soils, enable the road to carry the traffic most of the year without any serious destruction of the surface. A thin surface will permit a much greater length to be treated and will further permit the engineer to locate many weak places which can be corrected before additional surfacing is added.

The feather-edge method of construction has other advantages. The surface water that soaks into the roadbed has a better opportunity to seep out at the edges and prevent the softening of the subgrade or base.

The Trench Method

The trench method of construction is used where it is desirable to have the full thickness of gravel placed during the one construction operation and where the character of the soil is such that the surface water soaking into the gravel will not soften the subgrade or roadbed to any appreciable extent.

Where the trench method is used, lateral drains should be constructed at intervals or at low points where water is likely to accumulate and soften the subbase. The lateral drains may be constructed by digging trenches from the center of the road out to the side ditches and filling these drains with porous material. A sufficient number of lateral drains should always be constructed to insure the removal of all surplus water.

The Character of Gravel

The character of gravel to be used also determines somewhat the method of construction that is to be followed. A comparatively coarse gravel, or a gravel that has been crushed, can frequently be used in the trench method of construction better than the smaller gravel. In general, coarse gravel should be avoided in the building of a gravel road, as the coarse material will soon be exposed on the surface, which will result in a rough surface that is difficult to maintain by blading or dragging. Crushed gravel frequently makes a more desirable gravel surface than the rounded pebbles. In no case should gravel be used that contains pebbles in excess of 1½ ins. in size. The small size gravel is necessary, so that the road can be effectively maintained with the blade and drag. The success of any gravel surfacing depends very largely upon its maintenance, hence any material that can be dragged and shaped readily will make a much more satisfactory gravel surface.

An excess of fine material is also detrimental to a gravel surface, as there is not enough body to the material to resist the action of traffic. A very careful study of material to be used for building gravel roads should be made to insure maximum serviceability under traffic. While specifications are usually provided for the construction of a gravel road, it is very difficult to write a general specification that will meet all conditions. It is usually better to write a specific specification for the material available, from which the gravel road must be built. This procedure, however, is not always possible, hence a very liberal interpretation of any gravel road specification must be made when constructing this type of road.

Harrowing

After the specified thickness of gravel has been spread over the roadbed, it should always be thoroughly harrowed, to insure uniformity and to eliminate any hard spots that may have developed on account of dumping the gravel directly upon the roadbed. If the gravel be deficient in binding material it should be added at this time and thoroughly harrowed into the gravel surfacing. Harrowing should not, however, be continued to such an extent that it will tend to segregate the coarser particles and drag them to the surface. Traffic should not be allowed to use a gravel road until after it has been thoroughly harrowed. If the traffic is allowed to use the gravel road immediately after the material is dumped upon the roadbed, it is sure to be compacted in a way that will leave a rough riding surface. If proper care is taken during the placing of the gravel to get it thoroughly mixed and uniformly spread over the surface, much time and expense will be saved in finishing the road. If an irregular gravel surface becomes compacted under traffic, it is necessary to thoroughly scarify and re-harrow the entire road several different times to get a desirable riding surface. The use of form boards in lining up the edges of a gravel road and in securing the specified thickness of material over a uniformly prepared subgrade, aids in getting a uniform riding surface.

Blading

Maintenance during construction by blading with a light blade in order to keep the surface smooth and uniform during its compaction period, is very essential. In blading, only such material should be moved over the surface as is necessary to fill ruts and eliminate waves. A short, light drag is of little benefit and, in fact, is usually a detriment in the construction or maintenance of a gravel road. The drag cannot be regulated to move the proper amount of material over the surface. A drag frequently tends to deepen the low places and ride over the high places, which have become compacted, and thereby makes the road worse instead of better.

Provision for Maintenance

Inasmuch as the success of a gravel road depends very largely upon its main-

tenance, full provision should always be made for maintenance when the gravel road is being built. One of the best provisions for successful maintenance is to provide surplus gravel in stock piles at convenient intervals along the road that can be drawn upon as the surface needs additional material. While a gravel road is being built, therefore, storage piles should be provided. The storing of material of the same character as that of which the road is built insures a uniform riding surface and economy in maintenance.

RAIL, WATER AND HIGHWAY TRANSPORTATION AS VIEWED BY RAIL ENGINEER

By Robert H. Ford, Assistant Chief Engineer, The Chicago, Rock Island and Pacific Railway Co., LaSalle St. Station, Chicago, Ill.

(Concluded from March Issue)

It follows, therefore, that as the general public comes more and more to understand this—that it is their money that must be paid in continuous golden streams for the support and maintenance of duplicated or unnecessarily expensive means of transportation—and as the evolution of their dominant transportation agency progresses, they will become more and more insistent that the restrictive and hampering features be removed and that, as traffic gradually returns to its natural channels, railway rates will go downward, and decidedly downward. Every unnecessary expenditure required of or made by them and every passenger or ton of freight diverted to other agencies, must necessarily be reflected in its carrying rates for passengers and freight, the former affecting the individual actions of every citizen, while the latter enters into every form of his living and associations.

During the period of railway legislation, it was the popular thing for the politicians to attack the railroads. In many parts of the country, it became the greatest and surest vote-getting method. The more radical the attack, the greater assurance the politician had of success. Following in his wake came the blackmailer and the grafter of all shades and kinds. They settled like flies upon the transportation machine and for a time, railway advance was partly paralyzed. Near the end of this stage, came the Federal Railway Valuation Act, which was featured and passed on the theory that the railroads were vastly over-capitalized. It was confidently predicted that upon completion of the Federal Valuation thus authorized, when their real valuation was made known, that railway rates, based upon the capitalization, could be greatly reduced.

The result you all know. With the work practically complete, it has been found that the railways are under-capitalized by over two billion dollars or, in other words, if the public are to pay a fair return on investment, rates should go up instead of down. It has cost the tax-payers over one hundred million dollars to find this out and satisfy the railway baiters and well-meaning theorists, but it may be that it was worth its cost, if for no other reason than as a means of affording the public an example of some of this political "bunk."

The average railroad is today being operated at a cost greatly in excess of what would be economically possible if they were in a financial position to take full advantage of the opportunities afforded by modern science and invention. Could this be done, it would react for a reduction in railway rates, and the public would reap great benefits through proportionately reduced living costs, for, as I have said, living costs of every one are directly affected by transportation.

To accomplish this and operate these great agencies according to modern methods, requires heavier rail and heavier bridges, more ballast and the gradual substitution of creosoted and steel structures for untreated and wooden structures. These are necessary to support the larger cars with their greater carrying capacity and the longer and heavier loads drawn by larger locomotives, whose weight and tractive power have increased by over three hundred and six hundred per cent., respectively, within a relatively few years.

Engine houses, turntables, machine shops, and other terminal facilities required to house and repair these locomotives and cars must, in turn, be lengthened, and otherwise improved; the best form of labor-saving devices and automatic tools must replace manual labor wherever possible, with the resultant lowering of cost in producing transportation, no different from what is being done in other forms of well-managed industrial production; the great revolutions which have come about in railway

wages and working conditions have, in turn, caused corresponding increases in the costs of railway materials and supplies. These also require new and improved methods and devices, otherwise costs will increase instead of decrease.

Methods and ways that were practical and economical a few years ago are today correspondingly wasteful and extravagant. Railway gradients that were practical and suitable with the light engines and short trains of former years, are economically prohibitive for the great trains of more than double the length and capacity which modern requirements demand. Second main tracks, modern terminals, with the simplification and improvement of service attendant thereon, and roadside facilities are further necessities today. To meet these requirements, large sums of new money must be available, and with it comes the vast opportunities for the display of skill, talent, and scientific training of the railway operating man to so reduce the cost of maintenance and operation that he can produce transportation at a lowering cost. It would be a fine thing indeed if, as these savings are made available, they could be turned back directly to the investor and the public. However, if railway resources are to be depleted for things which are unessential, the public must continue to pay higher rates than would otherwise be necessary. For example: Expensive grade separations, which cost the railways from $25,000 to $100,000 each, when frequently a flashing light signal similar to the protection now being used in the cities could be installed for $1,500 and would adequately serve the purpose. Expensive stations and approaches in the face of decreasing use and revenue for rural communities or small cities whose ambitions will usually be found reflected in their tax rates, and many other items of similar nature, all of which are very fine and attractive, but compel the rate payer to pay the bill, and arrest, or badly distort, the economic development of the railways as a whole.

The average railroad today can show many items upon which a return of from fifteen to fifty per cent and more can be realized if the funds are available. If, and when, this can be secured, under the provisions of the Federal Transportation Act, under which the American Railway System now operates, the public will reap the benefits in lower rates and better service.

The Common Carrier Motor Vehicle

Meanwhile, there is being unwittingly built up, a rival agency which differs from the railways in that the railways are built by private capital, whereas the rival agency, in the form of good roads, is being constructed entirely at the public expense. The automobile has made the improved road a recognized necessity, and the social and commercial life of the citizens is greatly benefited thereby. Being thus a public benefit, all should pay to the extent that these roads become necessary and desirable and in proportion to the benefits derived therefrom.

Good roads have always been a necessity. The Roman roads of ancient times served at times for the preservation of the nation. No better medium for intercommunication can be found than properly constructed, commodious highways. As improved highways have been developed, they have been closely followed by a competitive transportation service which operates over these public thoroughfares for hire, for which the owners pay nothing and take all. The construction of the modernized public road must be made heavier and stronger to provide for this traffic, and maintenance and renewals, in like manner, are enormously increased to permit this free facility to operate over the improved highways. The taxpayer, as usual, becomes the "goat." He must pay both to provide the increased facilities and later, at an increased cost, to maintain them. Further, he must pay rates that are proportionately increased because he is maintaining two relatively weak agencies, where one strong one only should be necessary.

Politically, this is not a popular subject. The ramifications of the automobile truck and auto bus which are using the public highways free of charge have a far-reaching effect, and the desire to maintain them here to an extent far beyond what is either economical or wise is so irresistible that it seems probable that it will run its course before the general public awakes to a full realization of the situation.

It is not difficult, however, to see that these serve greatly to delay the time when railway rates can be substantially lowered, because the diverted revenues that would otherwise be devoted to the

improvement of the public service and enable the railway transportation agency to perform its functions more cheaply and economically are being frittered away in large quantities, either by compulsion on the railways as an aid in the support of the highways that make the rival agencies possible, or in the form of increased taxation for much the same purpose, and sometimes it is found working in both directions at the same time.

The problem confronting the railways today may be stated: How may the maximum economies in operation be secured with the relatively small funds available? To arrive at this represents the closest and most exacting study, the extent of which, if fully known, would, I am sure, surprise the average man. Not only must the individual railway be studied in all its aspects—past, present, and prospective—but it must be studied in comparison with all other competing railways, whose characteristics must also be known and intensively studied, and the results for the other railways studied and compared with each other, and finally with the railways as a whole. This might be likened to rival merchants of small capital in a community where the total annual business can be very closely calculated, who must compete with a mail order house, except in this case the analogy fails because the rival agency has unlimited capital, no comparable responsibilities, no interest, and no taxes.

This kind of competition has already resulted in a steadily decreasing mileage of the railroads. Last year, approximately six thousand miles of railway track serving many communities was pulled up because the revenues had become so small that they no longer would pay the bare operating charges in competition with the rival agencies which have sprung up and are operating over the public highways paralleling the railways and for which, by a curious twist of law, the railways are compelled to contribute toward the maintenance and support. In many cases, that has resulted in communities being left without any railroad transportation and in winter or inclement weather, practically isolated. A case in point is the Chicago, Peoria & St. Louis Railway, formerly a prosperous line 245 miles long, running from Peoria, Illinois, to St. Louis, Missouri, through some of the richest and most fertile territory in Illinois. The abandonment of this property will leave over fifty industries without means of marketing their products, and several enterprising Illinois communities will be left without proper means of transportation. The economic loss can hardly be visualized without some local study of the changes which this brings about in present and future values.

The period of normal renewal for the improved highways has not yet been reached in most states, consequently, the general public does not realize the vast sums that, of course, must be raised by taxation, in order to keep them in satisfactory condition. When this time does come (10 to 15 years hence) history will again repeat itself and it seems probable that the taxpayer will not be willing to continue to pay the bill and some other means must be taken; either the highways will not be maintained to their original standard, or else the users of the highways, and especially those who operate for hire, will be required to pay an increasing amount of the cost. There is already invested in bus lines, trucks, and other machines, operating for hire, a very great sum of money, and the investment is rapidly increasing. It is not reasonable to suppose that these transportation companies will willingly submit, without active protest, expressed, possibly, in some form of political effort, to assuming their part of the highway burden not contemplated when bus and freight carrying rates over the public highways were made in competition with the railroads.

It is more reasonable to expect that they will insist upon the public continuing to pay the bill for maintaining their right-of-way or the highway system over which their investment operates. Ultimately, however, if we can judge the future by the past, their rates will go up as they share this cost and as depreciation, taxes, and other charges are assessed, which will certainly result when the public comes to a better understanding of the realities of the situation. This can only result in a decreased service over these highways, with a corresponding return of this traffic to its natural agency, the railways. Unfortunately, however, many miles of railway track that have been removed under existing conditions may

not be replaced, or, if replaced, it must come as an added expense for which the rate payer must pay.

I have rather hastily sketched the transportation situation, because it appears to me to be, in its broader aspects, so essentially a problem of economics, consisting of factors for which the engineering profession is best qualified to deal.

The Engineer

The engineer of the present cannot measure his opportunities by those of the engineer of the past, because of the great changes that have taken place in industrial and social intercourse. This has perhaps caught a large number of men whose training has been for the old order—that of designing and constructing—in response to the requirements of the times. Engineering has been temporarily out-distanced by other agencies. Like the railroads which it made possible, the profession is, I believe, passing through something similar to the evolutionary process through which the railways are passing.

What is necessary today is not so much an engineer qualified to spend in design and construction of physical works but, rather, one who is also qualified, by reason of his knowledge, to save wisely and judiciously by not spending—a feat which others without his qualifications, training, and experience, do not usually know how to accomplish.

I think that our technical magazines may well consider whether they have not reached a point where their literature should develop more upon this feature than the long accounts with plans and illustrations of great works accomplished. Except for some details, usually of little immediate concern, these represent nothing more than the duplication of well-known features. They constitute labor and material molded into form, differing only in degree and character from similar works, the principles of which differ no more than does one crowd from another, except in size and character.

Rather, I think they should endeavor to place before their readers how expenditures may be avoided—how existing physical things may be so utilized that the minimum of investment is necessary; how their use of existing facilities can be intensified to a greater degree than heretofore; how the judicial functions of the engineer may be encouraged and developed so that he may at all times keep in his mind the fact that the truly great engineer is he who does not seek to accomplish through the expenditure of vast sums but rather, to secure the same, or better, results, with less. His problems are so frequently interwoven with the public welfare in some form or other that he, of all men, should be fitted to aid in steering through the sophistic plausibility of unhealthy investment and waste which is another name for inefficiency.

In addition to industry, the modern engineer must have vision, imagination, versatility, and the ability to convince his employer and associates that expenditures which affect the public interest will in the end be best secured by teamwork and co-operation of all the agencies affected, and to do this requires a broader understanding of economic principles than is ordinarily found with the average citizen, and very seldom with the professional promoter and politician.

The foregoing paper by Mr. Ford was presented at the 1925 meeting of the Illinois Society of Engineers.

WATER STORAGE A SOLUTION OF FIRE RESERVE PROBLEM

By Charles W. Parsons, Engineer, Illinois Inspection Bureau, 37 S. Wabash Ave., Chicago, Ill.

Many cities have a well designed water supply system which provides a sufficient amount of pure water at a satisfactory pressure for all domestic and industrial purposes. In these same cities an occasional large fire taxes these otherwise satisfactory water facilities to their limit and records show that many large fires, which have resulted in great property waste and sometimes in loss of human life, could have been checked before reaching conflagration proportions if a sufficient volume of water had been available.

Even in cities where conflagrations have been prevented by the efficient use of the available water and the fire fighting apparatus, the lack of a proper number of fire streams for handling a fire of long duration, which would be possible in the existing buildings, is an ever present hazard to the lives and property of the citizens and to the future of the city. This potential hazard is also reflected in

the cost of insurance throughout the city.

Fire Requirements Ignored

Engineering studies of the water supply systems in many cities of this State and of the country indicate that in all too many instances the various parts of those systems have been designed and improved to provide a supply that would be satisfactory for domestic purposes. Whatever fire protection that could be furnished by this equipment was deemed to be the best that the city could afford.

In many of these cities, and especially in the smaller ones, a comparatively small additional investment and sometimes merely a different design of the plant would provide a much more adequate and reliable water supply for effectively fighting the larger fires. Consulting engineers and water superintendents have a real opportunity to render very valuable service to their cities by giving special attention to the fire protection features of the water supply systems which they install and enlarge. Of the many parts of a water supply system which should be given careful consideration, it is the purpose of this paper to deal with but one, namely: Storage.

Amount of Storage Required

In order to determine the amount of storage that should be provided in connection with any particular water system, several factors must be known. The amount of water which is necessary to handle large fires in various cities has been given much study. The experiences of the most successful practical fire fighters, the opinions of the foremost fire protection engineers and the results of innumerable tests and actual fires have been condensed into definite figures in the form of the equation and tables compiled by the National Board of Fire Underwriters. This data is familiar, or should be familiar, to all consulting engineers and water superintendents. It is the basis for the requirements specified for cities of various sizes in the "Standard Schedule for Grading Cities and Towns," which is used as the basis for the fire insurance classification for all cities in this state and in most other states. As this data has frequently been published and is readily available it will not be given in detail here. These quantities required for the proper protection of the closely built districts of various cities have been found to be practically proportional to the populations of those cities.

For example, a city of 40,000 population requires a fire flow of 6,000 gals. per minute, one of 10,000 population requires 3,000 gals. per minute and a small city of 1,000 people requires 1,000 gals. per minute.

These quantities seem large in comparison to the average domestic consumption in cities of those sizes. This becomes particularly pronounced as we consider the smaller cities. The reason is very apparent. Even in most villages of 1,000 population there are two or more blocks of closely built mercantile buildings of generally inferior construction including numerous frame buildings and sheds and in many cases these are exposed by a lumber yard or a group of large area buildings.

A serious fire in such a location has the possibility and often the probability of a most serious calamity to the community. When efficiently handled, three fire streams of 250 gals. per minute each are scarcely sufficient to control such a fire. With an allowance of 50 per cent additional for waste from broken hose lines and services due to falling walls and other typical conditions incidental to a large fire, this minimum quantity will be in excess of the 1,000 gals. per minute specified. In the more extensive business and manufacturing districts of larger cities a correspondingly larger number of effective fire streams are necessary.

Domestic and Fire Requirements

The contrast between this quantity needed for effective fire fighting and that supplied for domestic consumption is especially marked in the smaller cities and villages. Many municipalities of 1,000 population, for example, use less than 40,000 gals. per day or an average of 28 gals. per minute in contrast to this 1,000 gals. per minute necessary to properly handle a large fire. Thus the requirements for fire protection are about 35 times those for domestic consumption.

With the increasing size of the cities, the difference is less marked although a factor of paramount importance in the design of the water supply system and in the reliability of the protection of human life and property from fire. Many cities of 10,000 population have an average domestic consumption of less than 800,000 gals. per day or 550 gals. per minute, while a fire flow of 3,000 g.p.m. is required for the corresponding mercantile district. This is over 5 times the domestic requirements. This difference decreases more or less uniformly to approxi-

mately 2½ times the domestic for an average city of 40,000 population, and becomes equal to the average consumption for one of 100,000 population.

Of course, in the still larger manufacturing and distributing centers of our country, the fire requirements are only a fraction of the enormous quantities normally supplied to the city and the problem becomes an entirely different one. We will consider here only the smaller cities where this difference is especially marked and where it is so often permitted to become a serious obstacle or at least an excuse against providing even a fair quantity of water for fighting serious fires.

Conditions in Smaller Cities

The cost of improvements and operation are often financed by one of several methods which eventually are dependent entirely upon the revenue from domestic consumption. There is often no direct income from the fire protection service rendered to the community. Whether or not this is the most equitable method is outside the scope of this paper. The result, however, is the natural one. The water supply system is designed and improved economically and effectively to perform the function for which the charges are made, namely: To provide sufficient pure, palatable water at satisfactory pressures for domestic consumption. A water works which furnishes this service uninterrupted is considered by the citizens as entirely satisfactory for the city's needs. This is especially true where the local fire fighters have been successful in stopping the fires in their incipiency, and the need of the larger quantities has not been forcefully brought home by a disastrous fire. The inability of such a system to meet the greater demands of a big fire is too often unjustly charged to the failure of a water works operator to perform his duty properly. A water works designed to handle a certain consumption with an ample factor of safety naturally will make a pronounced failure when called upon to supply from 5 to 35 times as much for a period of several hours.

Fire Pump

Where an ample and satisfactory supply is available at an advantageous location, the installation of a fire pump of sufficient capacity will completely solve this problem and will enable the domestic system to function admirably in the emergency of a big fire. The size and design of such a fire pump would depend upon the size of the city and the character of the water works. Pumps of 750, 1,000 and 1,500 g.p.m. have been very popular for such installations. A stand-by fire pump of this character should be provided with a gasoline motor of suitable size and design. This would partially offset the serious unreliability of depending entirely upon a single source of electric power for pump operation. Such an ideal water supply is often not available, however.

Storage the Best Solution

In many cities of Illinois and other central western states there are but one or two available sources of municipal water supply: Deep wells and surface streams. Wells are expensive to drill and the water in the majority of streams must be filtered before being safe for domestic use. In either of these cases the drilling of additional wells or the construction of sufficient filter capacity to provide this fire flow of several times the normal domestic load is usually a financial impossibility and unsound engineering practice.

The one solution of this problem seems to be storage; above ground clear water storage both in case of a well supply and where filters are used. If this storage is ample and is located near the city, the reserve pumps can deliver the necessary quantities to the fire. If the storage and pumps are at some distance from the closely built sections of the city it will be necessary to provide adequate and reliable supply mains to these points. In some cases the source of supply is several miles from the city and the high cost of additional lines makes it much more economical to provide a storage reservoir and stand-by pumps at the city end of this supply line.

Regardless of the local problems of the individual cities substantial storage and adequate reserve pumping capacity will practically always solve this problem of providing ample water to meet the demands of a serious fire. In so many of our mid-western cities where the supply is from deep wells or is filtered, the cost of providing this storage will be surprisingly less than the cost of maintaining well or filter capacity of from 5 to 35 times that necessary for domestic requirements. Is there any better way of solving this most important problem?

Storage Usually Insufficient

A surprisingly large number of Illinois cities have failed to appreciate the great

advantages of substantial storage. Many of these plants have even such small storage capacities that the filters and wells cannot be operated on the best schedule and when a brief shutdown is necessary for minor repairs the small storage is reduced to a dangerous minimum or entirely depleted and the service interrupted. Of 34 filter plants in cities of Illinois under 30,000 population, none has over 1,000,000 gals. clear water storage, only 7 have over 400,000 and the average is 308,000 gals.

The average storage provided at plants dependent upon deep well supply is often much less, frequently being as low as 100,000 gals., and sometimes being confined to such a small basin that the pump must be regularly operated with a partially closed discharge valve in order to equal the well yield. Such practice is obviously both very expensive and most unreliable even for attempting to furnish an uninterrupted domestic supply. Such cities would be entirely at the mercy of any ordinary fire in case of even a brief interruption of the well supply. The same would be true at a filtration plant where the supply of raw water might be temporarily checked or slight difficulties develop in filter controls just at the critical stage of a fire.

It is surprising and indeed startling to discover this condition in so many of the small water works of our state. No doubt this condition is equally prevalent in many other states. The encouraging part of the situation is the ease with which these plants can be made capable of furnishing reliable domestic service and even be improved sufficiently to handle adequately the large fire which is ever probable in that city. The cost of furnishing that service is within the reach of almost every community. It is one of the best paying investments that a city can make.

Water superintendents have a real opportunity to serve their city by recommending and actually installing adequate storage. Designing engineers have perhaps even a greater opportunity to render their client a service by including in their designs for improvements and for new plants, sufficient storage capacity to provide uninterrupted domestic supply and adequate quantities for fire protection.

Proper Storage Capacity

The proper storage capacity for a city of a certain size is readily determined. As previously mentioned, no storage whatever need be provided where an adequate supply is readily available near the point of consumption, if sufficient pumping capacity is provided for the peak loads. The other extreme is the small city with but one or two deep wells, or maybe one or two filter units, of a total capacity very little in excess of the domestic consumption.

While an additional well or filter should properly be provided and in fact as many such wells or filters as possible, the cost may be prohibitive. In such a case, sufficient storage should be provided so that the necessary fire flow may be furnished for the proper length of time. It has been found that this flow should be available for a period of 10 hours, except in cities under 2,500 population where a 5-hour period is the minimum. The excess of the maximum domestic and fire flow rates over the rate of yield of the wells or filters, is the rate of flow which must be provided from the storage during the necessary period.

As an illustration, a city of 1,000 population requiring a fire flow of 1,000 gals. per minute for a 5-hour period has a domestic consumption of 40,000 gals. per day and a deep well yielding 200 gals. per minute. Only 172 g.p.m. is then available to provide the 1,000 g.p.m. fire flow. The remaining 828 g.p.m. for 5 hours will be provided by a storage of 248,000 gals. If a 200 g.p.m. pump is used for discharging into the mains, the installation of a 100,000 gals. elevated tank, a 150,000-gal. suction reservoir and a 500 g. p. m. reserve pump driven by a gasoline motor would provide the necessary supply for domestic consumption and fire flow. This substantial reserve would also make it possible to make ordinary repairs without interrupting the domestic supply.

Larger cities would require correspondingly larger storage capacity depending upon the normal capacity of the wells or filters. In some plants in cities of from ten to twenty thousand, a storage of from 500,000 to 1,000,000 gals. and up would be necessary to provide the proper fire flow where the normal capacities were but slightly in excess of the average consumption. It might not be feasible in some cities to provide quite the total necessary fire flow but a very large proportion of this amount can practically always be provided in this way at a cost very much below the benefit derived.

Elevated Storage

Elevated storage is always of greater value than suction storage as it is immediately available without additional pumping. If the full amount of necessary storage could be provided at a sufficient elevation to furnish adequate pressure, the need of reserve pumping units would be eliminated. Suitable main capacity should be provided for the desired flow between this storage and the mercantile and manufacturing districts. In so many of the smaller midwestern cities the absence of hills limits this storage to the amount that can be feasibly provided by elevated tanks. A moderate amount of such storage is necessary for economical pumping.

Substantial storage makes it possible in small cities to operate the pumps for convenient periods during the day and in larger cities enables the peak consumption demands to be met without use of additional pumping units. Where an electrically operated station is dependent upon an overloaded power line, this storage enables the pumps to be shut down for the short evening maximum load period which may mean a saving in power charges. The capacity and height of an elevated tank depend upon the conditions in the individual city being considered. The old-style standpipe has been entirely superseded by the tank on structural steel supports as high pipes of small diameter were little better than surge towers as any moderate depletion of the storage would greatly reduce the pressure.

Even the smallest municipalities should have a tank of at least 100,000 gals. capacity and the majority of cities will find one of 250,000 gals. capacity a convenient size for efficiently handling the peak loads and for providing sufficient reserve while making minor repairs on the pumping equipment. A tank should be sufficiently high to provide a good domestic pressure in all parts of the city. An average pressure of perhaps 60 lbs. where buildings do not exceed two stories and perhaps 75 lbs. for other moderate sized cities enables the fire department to handle the majority of fires without the use of pumping engines. Such engines are needed, however, in all large cities and in those smaller cities where normal pressures are now or where they are reduced below the necessary minimum by the friction loss in undersized arterial feeders and by a weak gridiron. If possible the elevated storage should be located on the side of the principal mercantile district away from the pumping station so that in case of a break in the supply main from the station this storage will be available in the district.

Sufficient suction storage should be on hand to provide that portion of the rate of flow necessary for domestic consumption and fire demands which is not available from the source of supply and elevated storage. A reinforced concrete reservoir with a cover of similar material seems to be the most feasible design. If the location of the pumping plant is a central one, which is advisable, land values will probably dictate that the reservoir depth approach the practicable suction head of the pumps. For continuity of operation during repairs and cleaning, this reservoir should be constructed in two sections with pump suctions connecting to each.

Summary

In conclusion let us sum up the factors which point so strikingly to adequate storage as a most practical and economical solution of the fire reserve problem. A certain quantity of water is needed for a moderate number of hours properly to protect the lives and the property of the citizens of any city from destruction by fire. This necessary fire flow is much greater than the maximum rate of domestic consumption and becomes many times the domestic rate in the smaller municipalities. Where a sufficient supply of potable water is not readily available for maintaining this desired rate of fire flow, the cost of drilling sufficient additional wells or of constructing reserve filter capacity to equal from 5 to 35 times, the domestic rate would generally be a financial impossibility.

It is the aim of every city to provide the maximum possible protection as a safeguard against disaster by fire. The water supply works should be developed to their maximum economical limit. The difference between the normal rate of yield of these works and the rate of flow necessary for efficient fire fighting, can usually be most economically provided by adequate storage.

Such storage should be entirely elevated when practicable and mains should be of sufficient size and number to deliver the desired quantities to the various localities requiring protection. Where natural elevations are not available for reservoirs, a tank of substantial capacity

on a tower of sufficient height will be a most valuable asset to economical operation and a real safeguard against interruption of service. The remaining portion of the desired rate of fire flow can then be most economically provided by reserve pumps drawing from a sufficiently large suction storage reservoir. It is in providing this storage that designing engineers and water superintendents have one of the greatest opportunities to materially increase the adequacy and the reliability of the water works of the smaller American cities.

The foregoing paper by Mr. Parsons was presented before the 1925 meeting of the Illinois Section of American Water Works Association.

HIGHWAY RESEARCH REPORT ON CHARACTER AND USE OF ROAD MATERIAL

(Editor's Note: Following is a summary of the 1924 report of Committee No. 3 of the Advisory Board of Highway Research, on character and use of road materials. Mr. H. S. Mattimore, Engineer of Materials of the Pennsylvania Department of Highways, Harrisburg, was chairman of the committee.)

The report of the committee, given at the third annual meeting of the Advisory Board in 1923 which is partially published in Bulletin No. 43 of the National Research Council, listed twelve research problems which had been assigned to various members and upon which progress was then reported. These were chosen from the standpoint that they were problems upon which very little active research had been carried on and no definite conclusion had been drawn.

Now, we wish to report that further progress has been made and new agencies have become interested in them and they are being recognized as problems which have an effect on the durability of highway surfaces.

For instance, the durability of aggregate used in concrete probably has an effect on the durability of the concrete itself and accelerated tests to determine soundness of coarse aggregate are recommended. References and descriptions are given to tests of the crystallization class. Soundness tests on concrete mixtures may prove to have some relation to the durability on such structures as concrete slabs.

Some progress has been made toward the more accurate application of the design of concrete mixtures by proportioning the mixtures by weight. The committee considers that there is merit in this method of proportioning as it may eliminate many of the variables which have been determined in concrete strengths, probably due in some measure to inaccurate volumetric proportioning.

Several methods have been devised for the determining of the amount of cement in hardened concrete. A detailed study has shown that sources of error exist in each method and it is doubtful if any method published to date is of universal application.

In view of the variability of modulus of rupture test on concrete as affected by the ratio of span of beam to depth, it is recommended that research be conducted to ascertain such relationship and also to determine the influence of size of coarse aggregate.

The use of chains on trucks and some steel tired vehicles still makes it necessary to consider some wear tests for concrete. So far as our investigation shows, the Jones-Talbot test is not reliable.

Expansion failures of concrete road slabs and bases repeatedly occur on certain sections. The nature of the aggregates used has been given as the principal controlling factor. So far as we know, there is no published research data available on this subject.

The Ball Test has been used to determine the effect of different surface treatments used for curing on mortars. The results of these tests are now being studied.

The study of bituminous mixtures has been continued and the report discusses some recent investigations carried on by the Omaha Testing Laboratories, Bureau of Public Roads, and the Asphalt Association. The scheme and general outline of these tests are reported.

A comprehensive study of the present status of research on recovering bituminous materials without change from mixes is given. The merits of the different methods used are discussed.

The following problems have been suggested for study:

Calcium chloride as an accelerator and curative agent in concrete roads: There is some data available on this subject and since there is an insistent demand from the traveling public for the early opening of concrete roads we feel that

this problem is a very important one.

Durability of high aluminum cement, also investigate the use of this material for cold weather construction: The use of this material in the United States has been very limited to date. There is a demand for some such material in making replacements of concrete slabs or, possibly, even building short stretches of highways where it would be impracticable, or at least quite inconvenient, to establish detours.

The possibilities of using a high aluminum or quick hardening cement in testing concrete aggregates to accelerate results has many advantages. One series of results submitted by the Georgia State Highway Department on this problem is being studied.

Character of bituminous materials for surface treatment on earth and gravel roads: The phase of this subject which we propose studying is the character of such bituminous materials which have been reported as successfully used for certain conditions.

Zone paints from the standpoint of visibility for night and day travel: It is recognized that there is a difference in paints meeting the same specifications from the standpoint of visibility. This may be in the paint itself, the condition of the surface, or the method of application.

Owing to the variability of reinforced concrete culvert pipes now produced by different manufacturers, it seems desirable that researches be conducted to determine proper wall thickness, per cent of reinforcement, proportions, consistency and proper curing conditions, in order that such pipes may be of uniform quality.

This committee is working in a unique field as compared to similar committees in other organizations. We are not an active research agency as a committee. Probably the best description of our activities which might be illustrative is to encourage research on material problems and to act as a clearing house for progress reports on such problems. Finally, to be in a position of a board of review to judge of the merits of problems which have been presented and conclusions which have been arrived at.

In order to function efficiently we can consider that, first, we must have close contact with the highway engineering organizations where problems originate. Second, that we should be kept informed regarding the progress on these research problems so that the work can be properly correlated between the different agencies.

The committee feels that the Advisory Board on Highway Research is now organized so that these plans could be carried out. One of the best agencies for this purpose are the state contact men. With this in view, we contemplate sending out in the near future an inquiry to the different organizations through these contact men relative to the research problems which they would suggest for investigation. This will also call for the status of problems which they have under way. A prompt reply to this inquiry will place the committee in a position where they can select the live problems for investigation and keep the various agencies correlated.

Eventually, the greatest good would be obtained from this committee by properly correlating research on material problems. Independent investigators are likely to repeat some phases of the investigation which have already been solved by other agencies. It has also been found that some investigations have never been properly planned and outlined and, as a result, the data accumulated were of little or no value. Research operations are to be encouraged but if their results are to be of value they must be properly planned and outlined.

THE MOTOR VEHICLE AND MUNICIPAL EXPENDITURES

(Editor's Note: The General Legislative Committee of the New York State Conference of Mayors and other city officials, at its meeting on January 28, 1925, directed the chairman, Mayor Harry E. Clinton, of Troy, to send the letter here reproduced to each New York State Senator and Assemblyman. The claim of the local authority on a part, at least, of the motor vehicle revenues cannot long be denied. What are we going to do about it? How shall we finance state highways when cities, counties and townships make heavy inroads on the motor fees? The letter gives the municipal point of view. It is idle to dispute these assertions, no matter how friendly we may be to state highway development.)

Of the millions of dollars automobilists pay annually in license fees to New York

State not one penny is or can be spent within the limits of any city, with the exception of New York City. The 75 per cent which the state receives must be spent for the construction and maintenance of state highways outside of city and most village limits. The 25 per cent which each county receives must be spent for the construction and maintenance of county highways outside of city and most village limits.

The cities and villages contribute much the greater share of revenue received from motorists and they are compelled to spend annually considerable of their tax funds for the convenience and safety of both urban and rural motorists. The State has prohibited municipalities levying any tax on motorists. The following is a summary of the services which the automobile has forced the city and the village to give or extend and thereby increase its municipal expenditures:

1. The automobile is scattering our urban population over a greater area, thus compelling the city and village to provide more paved streets, fire and police protection, street lighting, street cleaning, water and sewers.

2. Cities and villages are now compelled to keep highways clear of snow to facilitate the movement of motor vehicles during winter.

3. The heavy truck has forced cities and villages to pay more for street paving. Formerly a 4-in. base under a pavement and a light man-hole cover were sufficient. Now cities and villages must construct a 6, 8, 10 and even 12-in. base, and provide heavy man-hole covers.

4. The vibration of heavy trucks is beginning to affect sewer and water mains. Some experts assert that municipalities will eventually have to lower their water and sewer systems.

5. To check or prevent an increase in claims for damages to motor vehicles, cities and villages are now compelled to keep their pavements in much better repair than when horse-drawn vehicles prevailed.

6. The motor vehicle has compelled cities and villages to provide more substantial and costly paving surfaces to overcome the wear and tear of automobile chains in winter; also more substantial and wider bridges to accommodate heavy motor trucks.

7. Police departments have had to be increased greatly to regulate traffic and parking for the convenience and safety of motorists.

8. Cities are now being compelled to provide parking spaces, other than in the highway; also to widen streets to accommodate increasing motor traffic.

9. The activities of the automobile thief have greatly increased the work of city and village police departments.

10. City and village streets must now be better lighted than heretofore for the safety and convenience of motorists.

For all of these new or increased services, made necessary by the automobile, the city and village taxpayer who owns a motor car pays no more in taxes for the municipal benefits received than does the person who does not own an automobile. And the state has forbidden the municipality levying any tax on motorists for these benefits.

The municipalities of the state most respectfully request the Legislature to give to them a fair share of the revenues now received from the automobile registration fees, or, if a gasoline tax is imposed, a fair share of the revenue received from that source.

We are willing that the state should limit the use of such revenue for the construction and maintenance of city highways and bridges and for snow removal, thus guaranteeing to the motorists that their tax or fee contributions will be used for their benefit.

NOVEL SEWAGE DISPOSAL PLANT AT JOHNSON CREEK, WIS.

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

Johnson Creek has the distinction of being the first village in the United States, if not in the civilized world, to have its sewage treated by a new and novel process. For the sake of an explanatory name we will call it the "Sludge Circulated and Aerated Process." Some may ask how did Johnson Creek come to have such a plant anyway? Well, it was like this: The old Imhoff Tank which was built about 10 years ago needed cleaning out (it had not been thoroughly cleaned out since it was built). There was no means provided when it was built to clean it except that a pipe was hung in the center of it. When we got at it we found that the central division walls, the parts that made it "Imhoff" were all rotted

away and had fallen into the bottom with the other debris. It took the village employes several months to get this old tank finally cleaned out so we could let a contract to fix it. I did not want the same experience to happen again. I wanted them to have a simple method of cleaning the tank and one that would keep it clean right along. I had previously tried out the use of air lift pumps for this purpose so I know they would work.

The plant was therefore designed to care for the present sewage and a liberal allowance for future growth. Mr. Milbrath measured the flow for several weeks. This meant that an addition had to be put on the old tank in the form of another tank making two compartments.

The inlet pipe was extended to a point near the bottom of the tank so as to discharge the solids at the point where we want them. This scheme is used in the Dortmund type of tank. The outlet was raised 18 ins. so as to get above high water. For the mechanical equipment we purchased a Curtis 4¼x4¼-in. air compressor driven by a 2-h.p. motor. In each tank we placed an air lift pump. These were made up entirely of pipe and fittings and have no valves or other moving parts below water. The pumps only work when the air from the compressor is forced to them. We found by experiment that it was not necessary to operate the pumps continuously but did find that the desired results were obtained when the pumps were operated at frequent intervals, so we concluded to try them three times per hour for five minutes at a time. To do this, it was necessary to have some sort of a clock switch that would start the motor at the proper time and shut it off in five minutes.

We first tried using a common clock with the hour hand for the contact switch but this did not work satisfactorily so a more substantial switch was devised. I could find nothing on the market that would do the work under a cost of $150. The one I made worked all right but it required winding twice a day. When I was called upon to devise similar plants for Mt. Horeb and DeForest I planned an entirely now switch which required winding only once a week. Now when the clock switch snaps the motor starts the compressor and compressed air is put into the two air lift pumps. The one in the first tank discharges its air, water and sludge into the manhole about 50 ft. in front of the plant. The one in the second tank discharges its load into the central cone of the first tank.

The process is continuous for a period of 5 minutes when the clock switch shuts off the current to the motor and the compressor stops. Then for a period of 15 minutes the sewage flows into the tanks and the sludge is allowed to settle to the bottom ready for the next pumping.

This action prevents the sewage from becoming stale or "septic." It also reduces the volume of sludge by breaking it up so that the chemical and bacteriological processes of decomposition can go on more readily. The presence of air keeps the sewage in an aerobic state; that is, bacteria which live in the presence of air can thrive on the organic matter contained in the sewage. When this process is carried on little or no obnoxious gases are given off, hence the absence of vile odors.

The above described action does not remove any sludge from the tanks but only assists in its reduction and purification. Whenever it is desired to draw off any sludge it is only necessary to open a valve of a bypass and close a valve on the pipe leading to the manhole and the sludge is discharged into a trough or tank to receive it. This sludge can be used for fertilizer, be buried or used for filling in low out-of-the-way places.

This process is somewhat like the activated sludge process which has been adopted for Milwaukee, but does not go nearly so far in the process of purification; that is, if we operated the air lifts longer or oftener, the nearer it would approach the Milwaukee system. It is also somewhat like the system recently put in use at Sheffield, England, where sludge is circulated by pumps without the use of air.

Since the installation was made for Johnson Creek, the village of DeForest has ordered a plant built of this type for their new sewerage system. Mt. Horeb has rebuilt their Imhoff tank system to correspond as closely as possible to the Johnson Creek system.

I am confident that this new system is a step in the right direction and will be used extensively in the future as a part of the most up-to-date systems.

INTERCONNECTION OF ELECTRIC POWER SYSTEMS

By F. H. Patten, Westinghouse Electric & Manufacturing Co., 1211 Equitable Bldg., Des Moines, Iowa

One may read occasionally in current trade papers and newspapers of a so-called Super Power Movement. Unless a proper perspective of the actual meaning of the term is attained imagination may picturize a monster corporate and mechanical structure. Probably the inventor of the phrase actually visioned a tremendous, highly efficient and economical system of plants and transmissions. My conception of the idea is one of relative values of magnitude. While the demand for power in congested industrial districts will require generating plants of very large capacity, there will be many other districts requiring comparatively much less centralized power. These may be situated very remotely from the super district but nevertheless deserve a proportionate share of the attention given to the subject. The problem then becomes one of transmission perhaps more than of generation. I believe, therefore, that the term "super power" is not sufficiently broad in its implied meaning.

Interconnection

Interconnection of electric power plants from the super-power standpoint is a rather new idea of not many years' standing. Actually, on the basis of the age of central station service, it is old. It was early recognized by engineers that some amounts of power could be supplied by transmission over certain distances more economically than if generated locally. I have been told that probably the first attempt at interurban power transmission in Iowa was made about 1899 when a 7,500-volt line was built between Council Bluffs and Omaha to allow the plant in Council Bluffs to be shut down. I understand that the second line was installed in 1901 between Waterloo and Cedar Falls at 11,000 volts so that the Cedar Falls plant might be shut down. Probably the first 33,000-volt, 60-cycle line in Iowa was installed between Perry and Grand Junction about 1912. Since 1912 rapid progress has been made until today there are many miles of high voltage lines.

A conception of the rate of increase may be helped by the knowledge that in 5 years from 1917 to 1922 the number of electricity distributors in Iowa decreased from 325 to 295 or 9.2 per cent. The private establishments decreased by 33 or 18.1 per cent while municipals increased by 3. This net decrease is reported as due to consolidations and extensions of transmission lines.

Alternating Current Violently Denounced When New

The early history of electricity transmission is very interesting particularly that part relating to the intense controversy caused when alternating current was first introduced. Direct current was the first form of electricity to be used commercially. When in 1885 one of the greatest pioneers of the electrical industry secured the American rights to the alternating current transformer and proposed to adopt alternating instead of direct current as the standard he was denounced as crazy. Almost every other electrical faction united to oppose the use of alternating current. They even made attempts to obtain legislation forbidding its use on the basis that it would be too dangerous to life and property.

Alternating current was considered unnecessary from the standpoint of higher voltages since they believed the direct current systems then in use to be sufficiently flexible and to have sufficient capacity for any probable future growth. Many also believed that electricity with a pulsating or directional reversing nature could not possibly be as efficient or hold out as many possibilities for utilization as one flowing steadily in a given direction. I understand that there is a letter in the archives of one of the nearby universities in which the author, a great contemporary of that period, states as his firm belief that economy would prevent electricity being transmitted any appreciable distance. He believed that the limit would be one-half mile and that a new plant would be necessary beyond that point, and so on indefinitely. Westinghouse, undiscouraged by the opposition, proceeded to develop his apparatus and build up a manufacturing organization. After studying the direct current systems he was convinced that there were strict limitations to the extent to which they could be expanded. The apparent market demanded a more flexible system. The logical method according to George Westinghouse was to transmit at higher voltages. The transformer was the best device to link safe and practical generating voltages to more economical yet safe transmitting voltages.

From a start at very low voltage direct current transmission over distances probably not exceeding one-half mile we have today AC systems as long as several hundred miles and up to 220,000 volts. In the earlier days of alternators it was believed by the manufacturers that 50 k.w. was the maximum safe generator capacity. Even up to 1893 the largest capacity attempted in one unit was built for the Chicago World's Fair. It was designed for 200 k. w. at 500 volts but was later found capable of carrying 300 k. w. at safe temperatures. In those days it had not been discovered that temperature bore a direct relation to machine ratings. It is not uncommon now to hear of ratings up to 50,000 k. w. in a single unit.

Merging Plants

Extensive electric systems have grown up in recent years by the merging with or absorption of power distributing companies by other nearby companies. Today the marketing of electric power is one of our greatest industries and one of our greatest public utilities. It must be generally true that they could not have reached their present proportions unless built on principles of economy. Many of them found it better economy to concentrate generation at a very few points and distribute the power long distances, in some cases abandoning plants entirely, in others maintaining them only for emergency service. It is true that in most cases each system is controlled as one organization but there are also many cases where interconnection has been made between foreign companies for the buying and selling of power at wholesale. Many of the latter have been in operation several years and demonstrated the possible economy of this method of service.

We may call attention to interconnections here in Iowa, the most notable being the Keokuk plant which sells large blocks of power to several different companies at St. Louis, Galesburg, Quincy, Alton, Burlington and other cities in addition to a number of its own allied companies. There are also a large number of small private systems and municipal plants in Iowa that are buying power from nearby larger operators at a lower cost than that at which they could generate. Out of 197 Iowa towns that at one time operated local plants only 60 continue the practice. Sixty others still operate distributing systems but buy their power at wholesale from other points. Seventy-three have abandoned their establishments or sold them outright to private companies. In most cases all or at least a major part of the power is transmitted to these towns.

Some Super-Power Systems

In other states many noteworthy systems have been in operation for several years. The super-power system of the Southeast in the Carolinas, Georgia and Alabama, consists of extensive interconnections between foreign companies, many of which generate largely by water power. The great advantage of this system was demonstrated during a recent severe and extended drought in part of the territory. The other territory had an abundant supply of surplus power which they were able to send to the unfortunate districts. Without the interconnection many people and industries would have suffered. On the West Coast there are extensive systems transmitting cheap power many hundreds of miles. Other extensive systems are operated in New Eng'and, Western Pennsylvania, the Middle West and Northwest.

Engineering Research

Engineers have been making an extensive research of this problem. It is a vast problem in its far-reaching factors. It deals with nature's resources such as water and coal, economics, standards of living, probable growth of industry and development of new lands. Fortunately there is much available data. The United States Geographical Survey has been recording useful information for years. Other departments of Federal and State governments also have compiled useful material. In 1923 a very complete atlas was prepared and published on the subject by F. G. Baum, an experienced hydro-electric engineer of the West Coast. The atlas treats the subject exhaustively in a nation-wide scope. There are also reports of a local nature. I may call attention to progress being made by the Power Survey Committee of the Great Lakes Division of the NELA. They have already published a report of their investigations in a certain area adjacent to Chicago including Milwaukee, Peoria, Springfield, Indianapolis, Toledo and intermediate towns. The report suggests an elaborate system of trunk lines interconnecting the larger sources of generation internally, as well as to sources outside the area. The recommendation is based on all contributory elements with

due allowance for probable growth up to 1950.

Satisfactory Apparatus Available

It is unnecessary to discuss at any great length in this paper the mechanical and electrical means of interconnection. Very satisfactory apparatus is available. It has been carefully developed to meet the severest requirements and has undergone the most severe tests of actual service. Undoubtedly the future will bring forth improvements in design and perhaps better methods and materials. For the present, existing apparatus permits the generation and transmission of large amounts of power at high voltages with satisfactory economy. Other devices provide safety to life and property. Metering devices are reliably accurate for power measurements which is essential especially where power is given and taken between companies or where accurate records are necessary to prove individual plant economy.

The present method of electricity transmission requires that power be put on the line at a certain voltage and be taken from the line at a slightly lower voltage. Since there is a certain percentage of the transmitted power absorbed in the line the generator must supply extra power in order to deliver the desired amount at the receiving end. The difference in voltage is due to the loss of energy which is absorbed in the line and which varies according to the characteristics of the line. On a complicated system where power is supplied at several points and removed at a multitude of points it can be readily appreciated that there would be a very uneven voltage distribution over the entire line. This condition requires that all the apparatus be adjusted to operate at different voltages depending upon location. Moreover, because each plant cannot always supply at the same rate, even absorbing power from the line at times as well as delivering at others, new adjustments all along the line are necessary at the time of each change. This condition results in great instability.

Constant Potential Transmission

The super-power or interconnection idea is most fully consummated when power may be given or taken at will at any point with the least effort and least harmful effect at other points. One engineer describes such a system as "Constant-Potential Transmission" and has developed a feasible method to maintain such a condition within practical limits. It is rather simple. By installing sychronous condensers and regulators at certain distances along the line, preferably at large load centers, a very uniform voltage at all points can be maintained. Automatic regulators will compensate for voltage differences by boosting or depressing as required to offset the variable condition of power movements. Condensers will supply the energy necessary to charge the line and compensate for the wattless current of low power factor loads. Without condensers the generators must supply this wattless current and use part of their capacity on non-income producing energy. The "constant-potential" method besides being more flexible will permit the generators to operate at more nearly 100 per cent power factor and will maintain the greatest reliability of service at all times.

Social Aspects

Without doubt the present day main issue of this question of power distribution is one of economics. More broadly, because it bears so importantly on the welfare of humanity, it is sociological. Economists tell us that there is a very definite and direct relation between the available power per capita in different countries and the standards of living and labor wage in those countries. In general terms the 1919 census report records about 3.25 installed horsepower per wage earner in the United States. It is reported that the horsepower ratio is approximately half this amount in England and one-quarter in Japan, while average wages are also one-half and one-quarter respectively.

Economists tell us further that very little human progress was made before the advent about 1800 of more usable forms of power. In all the long ages up to 1800 history records no human progress comparable to that which has kept step with the development of the steam engine and electricity. Living standards have improved apparently at the same rate as the availability of usable power.

We are told that human progress depends largely on the use of power. Man's energy is theoretically expended toward the production of two classes of commodities which we term necessities and luxuries. The standard of living depends on the rate of consumption of these. Any agency that will enable man to increase his production with the same or even less personal effort will raise his living stand-

ard by allowing him to consume more and a greater variety of commodities.

If higher standards require more power per capita the utilities are vitally interested as they are looking for better markets. If more power improves living standards the public should be vitally interested. Some believe that we are reaching in congested centers a point of saturation of the ratio of per capita horsepower that can be made available. It is thought that not much further raising of the living standard can be accomplished. Decentralization is recommended as a remedy and would be given impetus by greater distribution of low priced power over transmission lines.

Reasons for Interconnection

A few of the reasons why it is desirable to form power system interconnections deserve discussion. The length of this paper prevents any lengthy analysis or proof of their correctness. Most of them are self-evident or data may be obtained easily to verify the conclusion. They can be classified according to their relation to several points of view, i. e., consumer's price and cost of service, reliability of service, expansion of the industry, effect on other industries and conservation of natural resources.

Probable cost of service, upon which depends the consumer's price, is the most important factor. It seems necessary to consider only power for industrial uses as there are other much more important reasons than price for the use of electricity for residence, commercial and highway illumination. Electric power has had to compete wtih steam and other forms of power in the industries. In order to persuade various industries to abandon old forms of power it was necessary to show savings in cost or at least an increase of production at the same cost. The utilities have been obliged to look for every means of economy to meet the competition.

In the early days before capital investments became multiplied a large part of service cost was chargeable to fuel and man power. Boilers, engines, generators and labor-saving devices have reached such a stage of efficiency and investment in necessary distributing equipment has increased to such proportions that this factor is now a very small per cent of the cost. As much as 60 to 90 per cent of the total cost of serving the average residence and small commercial load—especially in small cities and towns—is now incurred after the energy has left the power plant.

Utilities find that a more constant use of equipment will decrease the cost per KWH. Since a plant must have sufficient capacity to carry the peak load plus a certain reserve much of the time a large part of the equipment was idle. Nevertheless, the income for energy sold must pay a return on the capital invested for the idle equipment. Baum states that his study discloses the fact that the combined output of all plants in the United States varies only about 10 per cent from month to month, while at individual plants it varies as much as 50 per cent. There is a considerable diversity factor of loads between remote localities. It may be due to difference of time, diversity of industry and habits. Where one isolated plant serves a restricted locality it must install full capacity plus a reasonable reserve. As soon as a system is extended to greater distances, finally taking in other stations the load factor improves. A further improvement on some plants may be obtained by throwing load from one plant to another in such a way that the most efficient plant can be operated at most nearly its best point. The other plants stand by for emergencies and jump in to carry the excess at times of peak load.

There is also a diversity of breakdown. It is improbable that machines would fail in different plants at the same time. This fact allows a smaller investment in reserve capacity. Several plants could depend on one or two plants for any reserve capacity they might need.

Hydro Developments

Much has been said lately about hydro electric development. There is a great difference between hydro and steam plant characteristics. Realizing that sometimes over 90 per cent of the cost of power from hydro plants is due to fixed charges, it will be realized that full value can be obtained from the equipment only where the load factor is high. In other words, the cost of operation depends hardly any on the energy output, whereas the cost of operating steam plants is somewhat proportional to the output since its percentage of fixed charges is only about 40. Moreover, some installations have shown the investment per KW of hydro developments to be more than twice that of steam or perhaps $185 and $80 per KW respectively. Hydro power also suffers from erratic stream flow.

Most of the hydro developments can be made to show fair returns on investment if all of the energy all the time can be absorbed in the system. This is another very good argument in favor of system interconnection. The larger the system the greater will be the minimum amount of hydro electric power that can be absorbed during light load periods. Also there is a stream flow diversity due to geographical location. A more extended system will connect more of these widely scattered stations and by creating a balance reduce considerably the effect of stream flow variations.

On this basis with relatively small extra cost hydro plants should be overdeveloped for full stream flow instead of being equipped for average stream flow. The base load on such a system ordinarily would be handled by waterpower while the best steam plants stand by for the peaks and emergencies.

New factors may enter the situation before many years to necessitate greater hydro development. Public opinion may demand greater conservation of our unreplaceable natural resources such as coal. Perhaps also the cost of generation by coal may increase to the point where it cannot compete with waterpower. Unfortunately the best sites are not favorably situated with respect to load centers but if extensive transmission systems are already constructed the chances are good that there will be much smaller distances to build for interconnection.

The cost per KWH of transmitting power varies considerably in different localities. Naturally it costs less per unit to transmit large blocks of power short distances than small amounts much longer distances. In agricultural communities it is often difficult to serve remote districts at a rate that is attractive. These often lie between the outposts of separate systems. An interconnection would make it possible to develop these districts more easily.

Interconnection has already demonstrated the greater dependability of power supply. In case of breakdown in a plant no time is lost in restoring service as it involves usually no more than the opening and closing of a few switches. Line failures also are reduced to minimum importance by ability to send power over several routes. Power failure is fatal to some kinds of industry so that extra precautions are taken in the form of interconnection of circuits.

The enormous growth in recent years of some of our large cities has taxed the ability of the utilities to build up its equipment at a fast enough rate. Many believe that if power could be served as cheaply at less congested points that industries would tend to decentralize and take advantage of other inherent advantages for its employes, such as cheaper rent, better and healthier living conditions, etc. Such a process would encourage the interconnection movement.

Another form of expansion of the electric utility besides into new territory is to find new and greater applications in their present territory. In agricultural districts there are beginning to be very great prospects along this line. By cooperation between utilities, state agricultural colleges and farm organizations, with a better understanding of actual conditions, great efforts are being made to make the use of electric power more attractive to the farmer through greater diversity of application. This is a fertile field the development of which will be assisted by more extensive transmission lines.

Waterpower is a natural resource replenished by nature. Coal when burned cannot be replaced. Much of more than 150 million tons of coal now used yearly in plants of industrial manufactures and other coal used in isolated utilities could be saved. Small plants now using as high as 10 to 20 lbs. of coal per KWH ought to be abandoned and power obtained from more efficient plants using only 2½ to 3 lbs. of coal per KWH. Additional benefits will be attained by releasing the equipment and man power of our railroads, now used in carrying coal, for the carrying of other commodities.

It is not always best economy to locate new steam plants at load centers or even at points of easy access to coal. A modern steam plant requires 500 or more tons of water for condensing the steam produced by 1 ton of coal. There are few localities where an abundance of water and coal are found close together. Since coal can be transported more easily than water the plant should be located near the water supply. Energy in electrical form can be transmitted very easily. The line from the new plant should make a very desirable addition to the super-power network.

Rapid Growth of Super-Power Expected

It seems reasonable to expect a very rapid growth of the super-power develop-

ment in the next few years. At least there will be, undoubtedly, more and more interconnecting of generating sources. Ultimately we may expect the entire country to be served by a complete network of trunk power lines extending east to west and north to south.

Consider the magnitude of our present telephone system. The ease of long distance communication would not be possible today without it. Imagine the inconvenience of transcontinental travel or even shorter journeys which might apply if our railroads had not developed means of through service for passengers and freight. More forethought and systematic planning in the early days probably would have saved these great utilities much of the cost of bringing them to their present magnitude. It is the duty of our engineers so to lay out future transmission developments that later the least expense will be necessary to put this desirable plan in effect. For instance, we have today too many so-called transmission lines, interconnecting important territories, the limited capacity of which makes them hardly more than overgrown distributing circuits.

Much of the future development of the idea of superpower depends on public opinion. Harmful legislation by opportunist legislators may be prevented if the public voices its opinion in its favor. To bring about this desirable condition the facts must be broadcasted. The great mass of people know nothing about the effort required to serve them. Their knowledge of the electrical subject begins at the point of turning on of the switch and ends at the paying of the bill at the cashier's window. Because the public does not absorb and retain facts readily and is always a prey to misguided pedagogues, the utilities should overcome this handicap by a systematic process of education, and make it certain that the public is correctly informed about this important matter.

The foregoing paper by Mr. Patten was read before the 1925 meeting of the Iowa Engineering Society.

THE PENNSYLVANIA HIGHWAY TRANSPORT SURVEY

By William H. Connell, Engineer Executive, Pennsylvania Department of Highways, Harrisburg, Pa.

A highway transport survey is nothing more or less than an investigation with a view to determining all the factors affecting the present and estimated future transportation requirements of a highway or a highway system.

A Guide to Construction

Two years ago Pennsylvania was virtually without such fundamental transportation information as traffic data and was facing a program of construction and maintenance involving an expenditure of $220,000,000 in 4 years' time. The need for traffic information to be used as a guide so that this money could be wisely spent in providing for the future traffic needs was self-evident and arrangements were made to make a comprehensive highway transport survey in cooperation with the United States Bureau of Public Roads and at the joint expense of the State of Pennsylvania and the United States Government. The purpose of this survey was to obtain information that would indicate the trend and possibilities of highway transportation and the future traffic needs of the highway system.

Information Sought

This involved a study of the present traffic on the highway system and the characteristics of the sections of the state traversed by and tributary to the highway with respect to the industries and density of population. This included:

A study of the population—Density of population per mile; increase or decrease in population in the last 10 years.

An economic and industrial study of the state embracing—Occupations of the population in the different sections of the state; areas of various industries such as manufacturing, mining (bituminous and anthracite coal, stone, etc.), oil, natural gas, agriculture, dairying, lumbering, unproductive forest areas, state forest reserves, resorts, etc., indicating the major changes in the importance of these pursuits during the past several decades.

The amount of production from the various pursuits in the different sections of the state indicating the major changes in production within the past several decades.

The origin and destination and percentage of the production of the state and from without the state transported over the highways.

The quantity of the different kinds of goods transported.

An estimate of the volume of commodi-

ties resulting from the various pursuits transported over the highways and the percentage adapted to highway transportation as compared with the percentage now handled by highway transportation.

The movement and characteristics of the passenger traffic including the origin and destination of the travel and whether business or recreational.

The present status of the public bus service and commercial trucking lines as compared with an estimate of the possibilities for expansion of these services.

These are just a few of the fundamental considerations embraced in the scope of the Pennsylvania highway transport study and all of which are factors to be considered in determining the earning capacity, not only of the entire highway system, but of the different routes and sections of highways.

Value of Hard Surfaced Roads

There is an accepted principle that no highway should be constructed at a cost in excess of its earning capacity and there can be developed from the facts evolved from this transportation study a definite return to the public in dollars and cents on any section of highway just as the return in dollars and cents can be shown on a section of railroad. The only difference is that the railroad's earning capacity is based on charging certain sums for transporting commodities and passengers, while the paved highway's earning capacity is based on saving definite sums to the people by using the highways for transporting commodities and passengers. The economics of highway transportation are in their infancy and there is yet to be formulated a comprehensive statement of the facts embracing all the factors entering into the earning capacity of a paved highway.

The transportation costs, for example, vary depending upon the character of road surfacing. For instance, it is generally accepted from tests that have been made throughout the country, that it costs about 40 per cent more for the fuel to operate a motor vehicle on dirt roads than on smooth hard surfaced roads. The items of motor vehicle transportation costs which are affected by the character of the road surfaces include depreciation, repairs, tires, oil and gasoline. Taking all of these factors into consideration, it is estimated that the total additional transportation costs for motor vehicles operated on dirt roads as compared with hard surfaced roads is 25 per cent.

From this it can be readily seen that where there is any appreciable amount of traffic using a dirt road, the saving in the operating costs for these vehicles on hard surfaced roads as compared with dirt roads would justify the construction of a hard surfaced road. For example, assuming an average operating cost per mile of passenger cars on hard surfaced roads of 10 cts., and an average operating cost of trucks of 36 cts., and an average traffic of 1,000 vehicles a day consisting of 90 per cent passenger cars and 10 per cent trucks, and operating costs on dirt roads 25 per cent more than on hard surfaced roads, the annual saving in operating costs per mile per year would be $11,500. The annual cost including interest, sinking fund and maintenance on a pavement costing $50,000 per mile would be only about $4,800 per mile. From this should be deducted the maintenance cost of the dirt road replaced, or about $500 per year. The additional cost therefore, under these circumstances, to the traveling public by the use of dirt roads as compared with hard surfaced roads is $7,200 per mile per year.

Just think of what this means in Pennsylvania at the present time. There is now a bill before the Legislature to make available a $50,000,000 bond issue. At an average cost of $50,000 a mile, this would build 1,000 miles of road, and as the greater portion of this mileage would be on the primary system or the main highways of the State, the traffic would probably average over 1,000 vehicles a day. But even assuming an average traffic of only 1,000 vehicles a day now compelled to use the dirt roads that will be paved out of these bond funds, for each year that this construction is delayed, the people of Pennsylvania will lose $7,200,000 a year.

If part of this money was not made available for immediate construction, as was suggested recently by one of the financial officers in Pennsylvania, and assuming for example that $20,000,000 of the $50,000,000 were not made available for two years, the cost to the people of the State through this delay in appropriating this money for construction, would be $2,880,000 per year, or $5,760,000 in two years. This would simply be an economic waste and it is inconceivable to believe that anyone having the best interests of the people of the State at heart could suggest delaying road construction if they knew these facts.

The additional cost in operating motor vehicles over dirt roads as compared with hard surfaced roads is only part of the cost due to delayed construction. For several months of the year the dirt roads are not travelable at all and during this time the inconvenience and loss to the people who are dependent upon these roads, if reduced to dollars and cents, would amount to a very considerable sum of money per year.

There is also a business loss of over $131,000,000 a year. That is the business that the increase in tourist traffic will bring to the State when the main highway system is entirely paved. This is particularly applicable to Pennsylvania at the present time because there are still 760 miles of road on the primary system to be paved before this great system of highways is entirely connected. These highways traverse the most beautiful sections of the State. Some of them will be unrivaled as scenic highways. It is safe to say that while the tourist travel and miscellaneous passenger car traffic from adjoining states now amounts to only about 10 per cent of the average daily traffic, when the entire primary system is paved, as it will be out of the bond issue which is to be made available, this travel will greatly increase and, as there is an average of over 400,000 passenger cars using the highway system every day, if the traffic from outside of the State only doubled, it would bring an additional 40,000 cars into the State. It has been disclosed through the highway transport survey just completed in Pennsylvania that the average number of passengers per vehicle is three, so there would be 120,000 additional people living within the State, and if they spent only $3 per day per person, they would increase the business of the State by $131,400,000 per year.

Thus far, except through the agency of the Pennsylvania Department of Highways, the Pennsylvania highways have not been extensively advertised to the tourists, but the State Chamber of Commerce has recently inaugurated a campaign to bring to the attention of the motorists throughout the country the advantages of touring in Pennsylvania. They have offered a prize of $200 for the best slogan to advertise the State to tourists. While this is not a large sum compared with the prizes some of the newspapers are now giving for cross-word puzzles amounting to $2,500 a week, still it unquestionably should and will bring forth some suggestions that will go a long way toward placing Pennsylvania on the map as a tourist state.

Necessity of Transportation Studies

Highway transport surveys are a fundamental factor of the highway business because without the facts developed from these studies the trend of the future traffic and the amount and character of traffic cannot be estimated and, therefore, a highway transportation system could not be intelligently planned. The determination of the necessary carrying capacity, width of pavement and the ultimate width of right-of-way to permit the widening of the pavements to provide for the future traffic, are all dependent upon the data obtained from traffic studies.

These studies are similar to those that are constantly being made by railroads, public service corporations and industrial concerns and by many of the large cities through the city planning engineers. We all know too well that scientific city planning to provide for the future requirements came into vogue about 100 years too late, with the result that the streets in the old cities are too narrow and in many cases it has cost untold millions to purchase and demolish buildings to widen the streets to provide for the traffic of today. Likewise, there are many examples of railroads, public service corporations and industrial concerns having made the same mistakes in not adequately and intelligently providing for their future needs.

There are also many instances where provision for future expansion without adequate information has resulted in an economic waste as the expansion has either not materialized at all or it has developed in some other direction than that in which the investment was made.

With these examples in mind, both in connection with our cities and railroads and public service and industrial concerns, there is little need of calling attention to the necessity of intensive traffic studies by the states so similar mistakes will not be made on the state highway systems.

The most important outstanding problem in the highway business today is the planning of highway systems that will adequately provide for the future traffic needs. It is the most important because it is fundamental. The engineering, supervision of construction, maintenance, etc., may be 100 per cent perfect, but un-

less the administrators have the foresight to make studies and investigations with a view toward laying out the highway systems of the future, they will have failed to administer the highway work on a sound engineering business basis. So would the administration of any railroad or public utility or manufacturing plant fail if it did not make all the necessary investigations and studies not only to keep abreast of the times, but to provide for their future business so they would be ready for it when it came.

There has been a tendency among engineers to stick too closely to the solution of the purely technical problems in connection with their work and overlook the importance of visualizing the problem from every angle so that they would know thoroughly the highway business. This business, like any other, can only be successfully administered through the agency of those who have been trained in all of its phases. It is not enough to know the technical sides of the construction and maintenance of pavements and bridges. The engineer should know where, when, and how to construct and to provide not only for the present day but for the future highway transportation needs. To plan adequately for these future needs it is necessary to have more than a general knowledge of the conditions throughout the State. It is impossible to plan intelligently without knowing all the facts that are directly related to or correlated with the highway transportation problem of the State.

Most of the highway systems are planned with a view toward connecting centers of population. There is, however, a wide variation in the number of people and in the business pursuits of the centers of population and surrounding territories. So there cannot be a uniform width of right-of-way for paved highways or one method of construction to suit the varying density and character of traffic in different sections of the country that would be sound from an economic standpoint. A uniform width of right-of-way for all the highways and pavements with a uniform carrying capacity would in some cases be insufficient and in others more than would be needed for the future traffic requirements. Any such policy would result in a great economic waste.

In the past, some railroads and many street railways and public utilities were planned in a sort of hit and miss fashion, as has also been the case with some of the cities and state highway systems. That is, they provided for construction of lines and extensions without making adequate studies and investigations relative to the probable future business, with the result that there have been a great many failures due to setting up the business of expanding in a territory where investigations similar to the highway transport studies would have developed the fact that there was no likelihood of sufficient business in the future to warrant the investments made to provide service. Competition is constantly forcing business to be conducted on a sounder economic basis. This has resulted in more scientific planning than heretofore. Decisions based on information obtained from investigations are taking the place of those that were formerly based upon the best guess that the business heads or boards of directors could make. This situation has been stimulated very much by conditions brought about by the war, which has reduced the buying capacity of the dollar to about one-half, thus making competition keener due to the struggle to give as much for the dollar as possible and at the same time make a fair profit.

This illustrates how competition in business has in a measure forced investigations similar to these highway transport studies, both to provide adequately for future expansion and to conserve resources and eliminate economic waste by spending no more than is justified to take care of the business requirements. If every state, or every section of a state, were in competition with one another, this phase of the business would have been given more serious consideration by the engineering profession in the past. Of course, we must not forget that it is only recently that the engineer has taken the highway business out of the hands of the butcher, the baker, and the candlestick maker and, therefore, he is not to blame for the present status. Now that the engineer is generally in control, these studies will undoubtedly become universal.

The highway industry, if not the biggest, is close to being as big as any other industry in the country today. The expenditures are not far from two billion dollars a year and on this work nearly one million men are employed. Before the war these figures would have been startling as prior to that time we seldom, if ever, talked in terms of billions

of dollars and millions of men. But even though they do not startle us now, it is a very serious problem involving the expenditure of enormous sums of money and every effort should be made to get whatever information is necessary and desirable in order to insure that the expenditures on the highway system will be wisely made.

This cannot be too forcefully stressed because the economics of the highway problem have not been given the consideration they deserve by either the engineers or the public. The engineer, due to his training, is more inclined to view the problem entirely from the technical standpoint, while the public, for some reason that is hard to explain, has not considered the highway problem a specialized business as they do the various lines of private business. This condition is largely due to the fact that it is public business, and, therefore, everyone has assumed he has a right to consider he knows as much about it as anybody else.

There is nothing that will do more to clarify this situation and bring about a better understanding than the facts that will be developed from the highway traffic studies. Those that have already been made have been a great education to both the engineer and the public. This was demonstrated in Pennsylvania. Before the traffic survey was started, traffic was discussed in general terms. The engineers as well as the laymen located in sections of the State that were thinly populated, felt that their main highway was just as important from a traffic standpoint as the main highways near the large centers of population. Many of the engineers visualized heavy trucking and passenger traffic in the future on all of the main highways of the State irrespective of where they were located. The terms "heavy," "medium" and "light" traffic were used in a general way irrespective of the location of the highways with relation to the varying densities of population. Heavy traffic is a relative term and what would be considered as a heavy traffic road in some sections of the State would be a light traffic road near the large centers of population. The facts developed have shown that the very heavy traffic is found only near large centers of population and the indications are that this will always be the case. There will be very little through passenger and truck traffic as the railroad is the more economic long distance transportation system. Through travel, therefore, is confined largely to tourists and some exceptional cases where it is more convenient and desirable to transport goods a great distance by truck rather than by railroad.

Traffic Data

The results of the survey indicate that 92 per cent of the traffic is local and 8 per cent through traffic. In the summer 85 per cent of the traffic consists of Pennsylvania cars and 15 per cent foreign cars. A number of the foreign cars constitute part of the local traffic in the counties bordering the adjoining states. The traffic count in these counties shows 75 per cent Pennsylvania cars and 25 per cent foreign cars. The traffic count of the counties in the central section of the State shows 96 per cent Pennsylvania cars and only 4 per cent foreign cars. The indications are that of the passenger travel, from 30 to 40 per cent can be considered as business travel. The winter traffic is about 50 per cent less than the summer traffic.

Prior to the traffic studies made in Pennsylvania, both the engineers in the department and the public had a greatly exaggerated idea of the amount and weight of truck traffic. It has developed that this traffic amounts to about 10 per cent of the total traffic and about 22 per cent of the total tonnage on the highways. The heavy truck traffic, or loads over 18,000 lbs., amounts to about 5.0 per cent of the truck traffic and only about 0.5 per cent of the total traffic. The heaviest truck traffic, or loads over 24,000 lbs., amounts to less than 1.0 per cent of the truck traffic and, therefore, less than 0.1 per cent of the total traffic. The truck traffic will, of course, increase but it will not take the place of the railroads as transportation of great quantities for long distances will always be more economically handled by freight trains. The heavier trucks, however, will greatly increase in the terminal areas near the large centers of population as they are being used more and more by the railroads, particularly for hauling less than carload lots.

In all the traffic surveys that have been made in the different states thus far, the fact has been brought out that the traffic varies in proportion to the population it serves. The most striking general illustration of this fact is the comparison of tributary population and traffic on two of our main east and west

highways, the Lincoln Highway and the Roosevelt Highway.

The Lincoln Highway crosses the southern portion of the State from Trenton, N. J., through Philadelphia and Pittsburgh to the Ohio line and is 360 miles in length. The population within an area of 10 miles of either side of this highway from the New Jersey line to the Ohio line, is about 4,500,000.

The Roosevelt Highway which enters the State at Port Jervis, N. Y., goes through Scranton, Towanda, and thence across the northern portion of the State through Warren and on to Erie and from there to the Ohio line west of Erie, and is 443 miles in length. The population which this highway serves within an area of 10 miles of either side of the highway amounts to 650,000. Of course, there are sections of this highway near Scranton and Erie where the traffic is heavy, but on the major portion it is very light and always will be as it serves only small centers of population.

The population of the area through which the Lincoln Highway passes is increasing very much more than it is in the area through which the Roosevelt Highway passes, so that this difference in traffic will increase.

The following are the maximum and minimum daily and hourly traffic on the Pennsylvania Highway system:

Maximum Daily Traffic

Date—September 27.
Day of week—Saturday.
Highway—Chester Pike.
Location—2 miles south of Philadelphia.
Population about 2,000,000.

Maximum Hourly Traffic

Time of day—1-2 p. m.

Trucks	66
Passenger cars	1,278
Total	1,344

Maximum 10-Hour Traffic

Trucks	610
Passenger cars	9,614
Total	10,224

Maximum 24-Hour Traffic

Total	15,864

The minimum daily traffic observed on week days was as follows:

Minimum 24-Hour Traffic

Date	Route		Pass. cars	Trucks	Total
September 16	221	Clearfield County, 4 miles south of Mahaffey	143	12	155
March 8	"	(Same)	6	3	9

Minimum Hourly Traffic—0

The following traffic figures on the Lincoln Highway between Philadelphia and Pittsburgh, a distance of 360 miles, illustrates the variation in passenger and truck traffic with relation to the centers of population. This highway is the most important in the State of Pensylvania and is termed the "main street' of the State.

Vicinity	Population	Average daily traffic	No. of trucks	No. of loads of 21,000 lbs.
5 mi. from Philadelphia	2,000,000	6,852	778	86
90 mi. from Philadelphia, close to York	47,512	3,042	466	18
200 mi. from Philadelphia, close to Bedford	2,330	995	94	4
68 mi. from Bedford, close to Greensburg	15,033	2,281	200	14
Just outside Pittsburgh	600,000	3,204	295	23

These traffic figures are near centers of population 100 miles or so apart and they in turn vary greatly between these points. For example, the traffic near York, which has a population of 47,512 and is about 90 miles from Philadelphia, is 2,576 passenger cars and 466 trucks, while traffic close to Coatesville, which has a population of 14,515 and is only 41 miles from Philadelphia, is 1,779 passenger cars and 266 trucks, or an average daily traffic of 997 less.

Another illustration of the relation of the traffic to the centers of population is shown by gross weight groups of trucks per day on the Lincoln Highway between Philadelphia and Coatesville, which is about 41 miles from Philadelphia and has a population within 10 miles of either side of the highway of 2,200,000, and the Lakes-to-Sea Highway between Erie and Meadville, which is about 38 miles from Erie and has a population within 10 miles on either side of the highway of 156,000.

Gross Weight Groups of Trucks

	Under 6,000 lbs.	6,000 to 12,000	12,000 to 18,000	18,000 to 24,000	Over 24,000	Total Daily
Lincoln Highway	99	73	49	27	22	270
Lakes-to-Sea Highway	22	17	1	1	0	41

The following average percentages of loaded trucks of different capacity and the average percentages of loads by gross weight groups at four different stations throughout the State are other illustrations of the kind of data that the highway departments need as a guide in conducting the highway transportation business. One of these stations is on a highway between Reading and Philadelphia 7 miles from Philadelphia, which has a population of about 2,000,000. One is on Route 153, 9 miles from Allentown, which has a population of 73,500; and one is on the Lincoln Highway about 2

miles west of Lancaster, which has a population of 53,000; and one is on the Susquehanna Trail about 4 miles north of Williamsport, which has a population of 36,000.

Capacities of loaded trucks (tons)	% in group
½—1½	56.2
2 —2½	19.5
3 —4	9.8
5 —5½	14.1
6 —7½	0.4

Gross weight of loaded trucks	% in group
Under 6,000 lbs.	52.3
6,000-11,999	24.0
12,000-17,999	13.0
18,000-23,999	7.2
24,000 and over	3.6

The following percentage of size and weight of trucks close to Philadelphia, with its population of 2,000,000 as compared with similar data taken close to Williamsport, with its population of only 36,000 illustrates the difference in the percentage of larger trucks and the heavier loads carried on the highways approaching the larger centers of population and the smaller centers of population.

Capacity Distribution (Loaded Trucks)

Capacity Groups (tons)	Pct. of loaded trucks Phila.	Williamsport
½—1½	47.6	76.2
2 —2½	24.4	13.5
3 —4	8.4	9.1
5 —5½	19.0	1.2
6 —7½	0.6	0.0

Gross Weight Distribution (Loaded Trucks)

Gross weight groups (pounds)	Pct. of loaded trucks Phila.	Williamsport
Under 6,000	38.7	90.9
6,000—11,999	31.4	7.5
12,000—17,999	17.0	1.6
18,000—23,999	7.4	0.0
24,000 and over	5.5	0.0

It will be noted, for example, that the trucks not exceeding 1½ tons represent 47 per cent of the total number of trucks on the Philadelphia highway, while the trucks not exceeding 1½ tons on the highway closest to Williamsport represent 76 per cent of the total. The percentage of gross weight loads on the Philadelphia highway under 6,000 lbs. represents only 38.7 per cent of the total, while the loads under 6,000 lbs. on the Williamsport highway represent 90.9 per cent of the total. On the Philadelphia highway 5.5 per cent of the loads are over 24,000 lbs., while on the Williamsport highway there are no loads over 24,000 lbs. and, in fact, none over 18,000 lbs.

There is a still wider variation in the percentage of light and heavy trucks in the data collected on heavy trucking highways close to Philadelphia and on highways in the rural sections of the State which contrast in a more marked degree the so-called industrial and rural highway.

On the Philadelphia highway 75.4 per cent of the total trucks were loaded and 24.6 per cent were empty, while on the Williamsport highway 60.6 per cent were loaded and 39.4 per cent empty. The approximate general figure for loaded and empty trucks near large centers of population as compared with rural highways near small centers of population is 70 per cent loaded and 30 per cent empty, while on the rural highways 55 per cent are loaded and 45 per cent empty, the reason, of course, being that near the large centers of population there is a greater opportunity to arrange for a return load than in the outlying sections.

Classification of Highways

Having in mind the principle that no highway should be constructed for a cost in excess of its earning capacity, this variation in the number of trucks of different capacities and weight of loads carried over the different highways emphasizes the necessity for a classification of routes and sections of highways based on the estimated future tonnage that the highways will be called upon to serve. It is perfectly evident that there will always be a considerable variation in the amount and character of traffic on different highway routes and sections of highway in all the states. This is due to the varying densities of population and the character of the pursuits or industries in the areas traversed by the highways. Some highways are so located that they are destined to carry heavy trucking traffic. Others are so located that they may carry moderately heavy passenger traffic but only medium truck traffic. Others are so located that they will carry only light passenger traffic and light truck traffic.

A classification of highways and standards of construction based on the future traffic needs for each class would necessitate limiting the truck loads to be carried on each class of highways to what the traffic studies indicate would be justified from an economic standpoint. For

example, if the traffic on a certain section of highway consists primarily of light truck traffic and that type of traffic seems to serve the needs of the section of country and communities through which the highway passes, there would be no justification for building that highway for very heavy truck traffic. Therefore, the vehicle load should be limited so that the very heavy truck traffic that might damage the pavement suitable for the lighter traffic, should not be permitted on this class of highway.

The classification to meet the varying traffic needs of the different states and within the different states should be somewhat as follows:

A. Terminal highways, or those in industrial areas connecting large centers of population not widely separated where there is a need for pavements sufficiently strong to carry a considerable number of heavily loaded large capacity trucks.

B. Main highways, or those connecting the county seats or centers of population throughout the State where there is a need for highways constructed sufficiently strong to carry a considerable number of heavy loads or large capacity trucks but of a lesser capacity than those permitted on the terminal highways.

C. Secondary highways, or those that consist of feeders to the main highways and where there is a need for highways sufficiently strong to carry a considerable number of loads of medium and moderately large capacity trucks.

D. Outlying highways, or those situated in the outlying sections where traffic consists chiefly of passenger automobiles and light truck traffic.

It is evident that such a classification is more to the point than the existing laws in virtually all of the states that permit the heaviest truck loads to travel over all the roads in the state irrespective of whether that weight of load is justified from an economic standpoint, with the result that one heavy truck very often completely ruins a pavement that is adequate for all the traffic that uses it except the one large capacity truck carrying very heavy loads.

Considerations Affecting Construction, Maintenance and Location

The present policy of the Pennsylvania Department of Highways is to plan and build in each instance to suit the individual probable future traffic requirements. It would be absurd to say that the same strength and width of pavement is required on sections of the north tier, or Roosevelt Highway, as is required on the Lincoln Highway near Philadelphia and Pittsburgh. The facts that have been developed from the highway survey in Pennsylvania have illustrated this so forcefully that the engineers in the Highway Department now always discuss the selection of the several designs of pavement used in the State from the standpoint of the relative future traffic needs on each section of highway.

When sections of highways are under discussion for construction, the design is determined upon after consideration of the present amount and character of traffic and the estimated future traffic. In planning the maintenance work for each year, it is necessary to take into consideration when the maintenance costs for repairing each section of highway have reached the economic limit and resurfacing or replacement would be justified. In order to make these determinations intelligently, it is necessary to know the present amount and character of traffic so that the future traffic needs can be estimated on each section of highway. For example, when the annual cost of repairs on a pavement approaches the annual cost of interest and sinking fund and estimated maintenance of a new pavement, the maintenance repairs should be discontinued and the highway should be maintained either by resurfacing or replacement. In order to determine intelligently just what type of resurfacing or replacement should be used, the estimated future traffic is absolutely essential as a guide.

To illustrate this point, take for example a light stone road or a gravel road where the traffic has increased to the extent that the annual cost of repairs seems to be excessive. The economic solution of this problem may be a bituminous surface treated macadam resurfacing, a penetration or bituminous concrete resurfacing, or a complete replacement with a concrete pavement or other durable type on a concrete base. In order to make this determination the estimated life of each type of surfacing under the estimated future traffic is the governing factor.

The information obtained from the traffic surveys is constantly used in connection with the location of the high-

ways. The location of the unpaved highways is determined upon after a thorough study of the economics of each individual situation. The report on each proposed relocation embraces a statement consisting of a comparative description of the present and proposed routes, the population of towns through which they pass, a description of the character of the country, estimated cost of construction and maintenance, amount of damages for right-of-way, and the annual operating costs of the estimated future traffic of each location under consideration.

The economics of the location of highways is of very considerable importance. The through routes particularly should be located with a view toward carrying traffic by the shortest route and over roads with reasonable grades and curvature. Most of the roads were laid out for local horse-drawn traffic without much consideration being given to selecting the shortest route between distant points. The old highways, therefore, are not as a rule on the economic location.

The average motor transportation cost to highway users for each 1,000 ft. over a hard surfaced road is approximately $0.23 for each vehicle. Therefore, the cost for 1,000 vehicles a day would be $23.00, or $8,395 per year, or $167,900 for 20 years. Many relocations are made which result in shortening the distance more than a mile. Based on these figures, the saving to the users of each mile would be approximately $44,300 a year, or $886,000 for 20 years. These figures are based on 90 per cent passenger and 10 per cent traffic.

The relocations thus far in Pennsylvania have resulted in a saving of approximately 100 miles. With an average traffic of 1,000 vehicles a day, the saving in operating costs is approximately $4,430,000 per year. Adding to this $480,000 which includes the average annual cost of 100 miles of pavement made up of interest on the investment, sinking fund requirements for bond issue, and maintenance costs, makes a total of $4,910,000 per year.

Financial and Social Aspects

In 1924 the State highway work in Pennsylvania represented a business involving an expenditure of $55,000,000. It would be a very easy matter to waste a considerable amount of this expenditure if a guess, rather than facts as developed from a highway transport survey, was used in determining upon the design of construction, the width of the pavements, and the ultimate width of right-of-way to serve the future traffic needs for the varying conditions that exist today and will always exist throughout the State.

The data obtained from the survey contain records that are available as a guide in carrying on the work on the highway system to the best advantage. Traffic information is just as necessary intelligently to plan and conduct a highway transportation system as it is for a railroad system the money spent on highway transport surveys will save fabulous sums that otherwise would have to be charged to economic waste through lack of intelligent planning resulting in unwise expenditures.

Highway transportation affects everybody from both a social and business standpoint. The highways are used by virtually every individual for both business and recreational purposes. This means of transportation is within the reach of almost everyone and the number of people using the highways will increase from year to year. Highway transportation is the big thing in present-day life in the outlying sections of the country as well as in all centers of population. There is no section of the United States where highway transportation is not one of the principal needs. It, therefore, cannot be stressed too forcefully that any problem or undertaking that affects everybody and costs such an enormous sum of money as is being spent on highway construction and upkeep, should be the subject of the most thorough investigation in order to plan wisely and economically highways that will serve the future traffic needs.

The foregoing paper by Mr. Connell was read at the 1925 Conference on Highway Engineering held at the University of Michigan, Ann Arbor, Feb. 18, 1925.

NOW ONLY FOUR STANDARD SIZES OF PAVING BRICK

From 66 to 4 recognized types and sizes of vitrified paving brick is the simplification record of the paving brick industry in the short period of four years, according to announcement just made by the Permanent Committee on Simplification of Varieties and Standards of Vitrified Paving Brick of the United States Department of Commerce.

At the recent meeting of the committee held March 20, at Washington, D. C., the committee eliminated one of the five remaining types and sizes of brick, thus cutting down the officially recognized list to four in number.

Following are the recognized types and sizes:

	Depth, ins.		Width (as usually laid), ins.		Length, ins.
Plain Wire-Cut Brick (Vertical Fiber Lugless)	3	x	4	x	8½
	3½	x	4	x	8½
Wire-Cut Brick (Dunn)	4	x	3½	x	8½
Repressed Lug Brick	4	x	3½	x	8½

The variety eliminated by the committee, after thorough study of the shipments for the entire industry for the year 1924, was the 3x3½x8½-in. (Dunn) wire-cut lug brick. This particular variety had shown a consistent decline until it represented only 2 per cent of the total shipments in 1924.

Of the total 1924 shipments, 82.1 per cent were in the four types and sizes now recognized by the committee. The most marked growth of any special outside of the recognized list was that of the 2½x 4x8½-in. vertical fibre (plain wire-cut) brick. This size and type increased from 2.2 per cent of total shipments in 1922 to 4.4 per cent of shipments in 1924. Reports from manufacturers indicated a decided trend toward a thinner brick for paving streets and highways of light or medium traffic.

It was the judgment of the committee that the year 1925 would in all probability determine the value of this thinner brick and that including it in the list of recognized types and sizes could be given careful consideration at the next meeting of the committee in 1926.

NEW STREET LIGHTING SYSTEM AT INDIANAPOLIS

More than 4,000 new street lighting units are being installed in the business and residential sections of Indianapolis, which has decided to carry out one of the largest programs of the kind yet undertaken. When the work is completed, the Indiana metropolis will rank among the best illuminated cities in the country.

The Merchants Heat and Light Company, which has been awarded a 10-year lighting contract by the municipality, has placed an order with the General Electric Company for 1,378 Novalux lighting units with rippled alabaster globes and canopies for mounting on standards, and 2,750 Novalux pendant units with light alabaster rippled globes, each equipped with an internal dome refractor. These will replace globe and series flame arcs.

For the past 10 years and under the terms of the old contract, the business streets have been lighted by 150-watt multiple lamps in 16-in. ball globes mounted on 11-ft. posts and spaced approximately 85 ft. apart on both sides of the street, and, at some street intersections in the business districts, by pendant 10-ampere, a.c. series flame arc lamps supported on tubular steel poles and mast arms. All the streets in the residential sections were illuminated by 10-ampere, a.c., series flame arc lamps.

In the principal business districts the new system will consist of 225 two-light, ornamental Union Metal Company standards equipped with Novalux lighting units. These units will have medium alabaster rippled globes and canopies, enclosing a 15,000-lumen, 20-ampere incandescent lamp. The standards will be placed opposite each other at intervals of about 105 ft., and the light source will be 19 ft. above the sidewalk.

Single-light Union Metal Company standards, equipped with the same Novalux units and 15,000 lumen lamps, will be used in the secondary business district. The standards will be installed in parallel and in staggered formation, depending on the character of the street and the intensity of illumination required. The spacing will vary from 105 to 125 ft.

An interesting and inexpensive feature of the standards for the business districts is that whenever the city desires an extension of the twin-light units, the single-light standards, which are 14 ft. 10 ins. high, can be changed into twolight standards 19 ft. high merely by the application of a top ornament and without the necessity of setting a new pole.

Eleven hundred and forty-nine Union Metal Co. standards equipped with Novalux units furnished with light alabaster rippled globes and canopies will be used there, 453 of them being equipped with 6,000-lumen, 20-ampere lamps, and 696 with 4,000-lumen, 15-ampere lamps.

The standards will be spaced at intervals of approximately 125 ft. and will be

placed opposite each other. An individual lamp transformer will be mounted in the base of each standard, and the primary winding will be connected to a 10-ampere a. c., series underground circuit. Part of the underground circuit will be 5,000-volt lead covered cable in duct, and part will be 5,000-volt lead covered and armored parkway cable laid in the ground.

The overhead pendant Novalux units will have light alabaster rippled globes with an internal dome refractor. They will be equipped with 10-ampere primary compensators for either 10,000 or 6,000-lumen incandescent lamps so that the fixtures can be placed on the same circuit and controlled by the 10-ampere regulators which were used formerly for operating the 10-ampere flame arcs. Three thousand of these units will be used this year to take the place of the flame arcs. Of these, 2,200 will be equipped with 10,000-lumen, 20-ampere lamps, and 800 will be operated with 6,000-lumen, 20-ampere lamps. All these will be operated all night on a schedule of 4,000 hours per year.

A total of 2,297 ornamental units will be installed this year, of which 1,147 will be operated on an all-night schedule of 4,000 hours per year and the remaining 1,150 part of the night on a schedule of 2,000 hours per year.

DIGEST OF SOME RECENT A. S. T. M. COMMITTEE REPORTS

Meetings of 12 committees of the American Society for Testing Materials, in the non-metals division, were held at the Bellevue-Stratford Hotel, Philadelphia, Wednesday, Thursday and Friday, March 25, 26 and 27. They were attended by about 200 members and visitors, comprising engineers and technical experts from the principal cement plants of the country, stone and gravel producers, tar and asphalt companies, pub'ic utilities, municipalities, and the Federal Government. The national officers of the society, President F. M. Farmer, New York City; Vice-President W. H. Fulweiler, Philadelphia, and Secretary-Treasurer C. L. Warwick, Philadelphia, were present and addressed the meetings.

The society is a national technical organization of some 3,600 members with headquarters at 1313 Spruce street, Philadelphia, formed for the purpose of promoting knowledge of the materials of engineering and standardizing of specifications and methods of testing engineering materials. The society meets annually at Atlantic City in June. Between these meetings its work is carried on by about 40 committees, who study various materials, conduct tests to advance knowledge of these materials, so that engineers may know better how to use them, and prepare standard specifications and tests to govern the interchange of these materials between the manufacturer or seller and the consumer or buyer. Because of the great commercial importance of this work on specifications, the committees are made thoroughly representative of both the manufacturers of the material or product and the users. Experts who are neither manufacturers nor users also serve on the committees. In this way the points of view of all three groups are brought directly into contact with each other and standards satisfactory to all parties at interest are reached.

Committee C-1 on Cement

(Chairman: R. S. Greenman, Senior Assistant Engineer, Department of State Engineer, Albany, N. Y. Secretary: R. B. Young, Senior Assistant Laboratory Engineer, Hydro-Electric Power Commission, Toronto, Ontario, Canada.)

Committee C-1 on Cement held a well attended meeting on Wednesday, March 25, at which 40 of its members, coming from all sections of the country, were present out of a total membership of 59. General discussion centered upon the Society's Standard Specifications and Methods of Test for Portland Cement, which have been approved as American Standard Specifications by the American Engineering Standards Committee. The comments of many members and certain reports mentioned below brought out sharply that one of the biggest problems before the committee today is to devise further means for improving the degree of uniformity obtained in test of cement throughout the laboratories of the country. The committee has been at work upon a handbook or manual which elaborates in considerable detail the directions in the specifications for making the several tests called for, that is, fineness, soundness, time of set, and tensile strength. Mr. Ernest Ashton, Chemical Engineer, Lehigh Portland Cement Co., Allentown, Pa., chairman of the sub-committee in charge of this matter, stated that the manual was practically complet-

ed and would be submitted in tentative printed form for consideration of the committee at its next meeting.

Another interesting feature of the meeting was the consideration by the committee of the recently proposed Master Specifications for Cement that have been issued by the Federal Specifications Board. The Master Specifications have not changed the actual requirements of the standard specifications but in many cases have elaborated upon the methods of testing in somewhat the same way that the committee itself has done in the above mentioned handbook.

Reports from the following sub-committees are worthy of mention:

Sub-Committee on Specific Gravity.—The sub-committee has recommended that the requirements for specific gravity be dropped from the specifications. This recommendation has been approved by the committee and will be submitted to the society at the time the other recommendations respecting the specifications are made.

Sub-Committee on Fineness.—Mr. J. C. Pearson, Assistant Chemical Engineer, Lehigh Portland Cement Co., Allentown, Pa., the chairman of the sub-committee reported that they have been making some studies on the relation of fineness to strength and have presented some interesting data for consideration by the Sub-committee on Strength. They have recommended the adoption by the committee of a new series of testing sieves that are being brought out by Committee E-1 on Methods of Testing. The committee has planned a study of the standard Ottawa sand with the use of these new sieves with the object of so fixing tolerances that the present standard Ottawa sand may be used without modification.

Sub-Committee on Strength.—Mr. P. H. Bates, Chemist, Bureau of Standards, Washington, chairman, reported the results of an extensive series of strength tests made by 17 cooperating laboratories. These tests included compression tests of cylinders and cubes, and tension tests of mortar briquettes, with different consistencies of mortar, different proportions and at different ages. The magnitude of this work will probably be appreciated by the fact that the number of specimens involved in this series alone is approximately 40,000. The results bear on the methods of testing, but inasmuch as the sub-committee did not have an opportunity to work up these data, it is too soon to state any conclusions. In the meantime the sub-committee has been directed to tabulate and study these data, for which Committee C-1 has appropriated the necessary funds.

In the same connection Mr. F. H. Jackson, Senior Assistant Testing Engineer, U. S. Bureau of Public Roads, Washington, D. C., presented an interesting paper giving in detail results of a series of comparative tests in some 50 laboratories which bear upon the work of Sub-Committee VII on Strength. One of the objects of this investigation was to determine the degree of conformity in applying the standard tests to identical samples prepared and sent out by the Bureau of Public Roads and tested in accordance with the standard methods. The purpose of the paper was to point out to Committee C-1 some of the methods of testing that needed elaboration.

As a result of the discussion of these two series of tests certain investigations supplementary to those now in progress were discussed and were referred to the sub-committee for consideration.

Sub-Committee on Natural Cement.—Mr. E. L. Conwell, President, E. L. Conwell & Co., Philadelphia, chairman of the sub-committee, reported progress and promised further information on the subject of natural cements at the next meeting.

So much business of importance developed at this meeting requiring further consideration of the committee before it could properly prepare its annual report to the Society in June that it was determined to hold another meeting in New York City on May 15, at which further data now in course of preparation will be reviewed and the committee's annual report prepared.

Committee C-9 on Concrete and Concrete Aggregates

(Chairman: A. T. Goldbeck, Chief, Division of Tests, Bureau of Public Roads, Washington, D. C. Secretary: J. C. Pearson, Assistant to Chemical Engineer, Lehigh Portland Cement Co., Allentown, Pa.)

Committee C-9 on Concrete and Concrete Aggregates is proposing to revise its Tentative Methods of Securing Specimens of Hardened Concrete from the Structure (C 42-21 T) to include a table of reduction factors for specimens of varying ratios of height to diameter, so as to refer such specimens to the standard specimen having a ratio of height to diameter of 2

to 1. The Tentative Methods of Making Compression Tests of Concrete (C 39-21 T) are being recommended for advancement to standard.

A new sub-committee has been appointed on Design. There are at present a number of theories governing the design of concrete mixtures. It is the work of this new sub-committee to align these various theories. The committee is working on new specifications for aggregate and on specifications for concrete. In order to aid in the securing of data on available deposits of aggregates, a form has been prepared on which to record the essential information concerning any deposit. This should serve as a guide in getting specific information.

A sub-committee, which is carrying on a study of various natural or artificially occurring materials in concrete which may affect it deleteriously, will compile as a first step a bibliography on the effects of these various deleterious substances. Such materials include organic impurities, impure water, etc.

Another sub-committee is studying the effect of various admixtures in concrete. It believes that its first efforts should be the preparation of a standard method for determining the weight per cubic foot of the various powdered admixtures, since at present there is no method that has been agreed upon as a standard method. It will carry out a series of cooperative tests in which nine laboratories will determine the weight per cubic foot of powdered talc, oil shale, hydrated lime and diotamaceous earth, by the rodding method and direct compression method and compression by means of jigging. The sub-committee will ultimately look into the effect of these powdered admixtures on the strength of the concrete, including in this investigation the effect of similar additions of portland cement.

The durability of concrete under various conditions is a subject of great economic importance. If some concrete will stand up much longer under a definite set of conditions than other concrete, it would be enlightening to know the reasons. It may be that certain precautions can be taken to insure greater durability. One suggestion to accomplish this is a soundness test for aggregate. This is a sodium-sulfate test used to simulate freezing and thawing conditions. Any accelerated test would be very helpful.

Committee D-4 on Road and Paving Materials

(Chairman: H. S. Mattimore, Engineer of Materials, Pennsylvania State Highway Commission, Harrisburg, Pa. Secretary: Prevost Hubbart, Chemical Engineer, The Asphalt Association, New York City.)

At the meeting of Committee D-4 on Road and Paving Materials, considerable attention was given to the question of subgrade soils. The committee is recommending a tentative field method for determining moisture equivalent of subgrade soils, which is the most indicative test of the suitability of the soil to serve as a subgrade of the road. By its use can be determined what special treatment must be given to the design of the pavement.

The committee voted to recommend to the Society at the annual meeting that the Tentative Method of Test for Consistency of Portland Cement Concrete for Pavements or for Pavement Base (D 138-22 T) should be advanced to standard as this test is significant in controlling the strength of concrete. It should be pointed out that it has been found that wet mixtures are greatly inferior in strength to those containing a lesser amount of water. By the use of this proposed method a higher quality and more concrete is possible.

A number of revisions of tentative and standard methods is under consideration, including revisions of the method of float test method of mechanical analysis of subgrade soils, standard method of test for specific gravity, standard method of test for distillation and standard method of test for penetration. The revision of the latter method involves a change in the requirements for the penetration needle, which should make it possible to secure standard needles more readily than heretofore.

The committee is making a strong effort to produce a standard for commercial size broken stone, slag and gravel. There is possibility of considerable economy in the elimination of unnecessary screen sizes in commercial producing plants. At present plants are forced to carry in stock a large number of screens, which could be replaced by a comparatively small number.

The committee is also engaged in the preparation of specifications for gravel, stone and slag for various types of construction and it is giving considerable study to the design and methods of testing bituminous concrete mixtures.

WATER TREATMENT AND SOFTENING PLANT AT SPRINGFIELD, ILL.

By C. S. Timanus of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

Illinois, in common with most of the central and western states, is notable for its hard waters. With the exception of supplies taken from Lake Michigan all others of the state may be termed hard. Those from the rivers vary over wide ranges, of course, depending on the flow of the stream, while the well supplies are universally classed as extremely hard. Of 338 municipal well supplies reported by the State Water Survey, 300 have a hardness of over 300 parts per million. Of the well waters, the rock wells of the northern part of the state supply water much harder than the shallow or drift wells which are found generally in the southern part of the state.

Water Supply of Springfield

The water supply at Springfield is taken from drift wells and infiltration galleries drawing from the shallow sands of the Sangamon River valley north of the city. This water exhibits the same characteristics as the other shallow ground water supplies of the state, having a hardness of 280 to 300 parts per million. Of this hardness, about 60 per cent is due to calcium bicarbonate, 25 per cent to magnesium bicarbonate and 15 per cent to magnesium sulphate. Laboratory tests indicate that the water is very easy to soften.

In addition to the high mineral content resulting in hardness the water also contains iron in appreciable amounts, averaging about two parts per million. This iron is present in the form of ferrous hydroxide when the water first comes from the wells, but on being exposed to the air is oxidized, resulting in a reddish brown precipitate and a slight turbidity.

The operation of an experimental plant at Springfield indicated that while a part of the iron could be precipitated by the simple process of aeration and sedimentation the colloidal or finely divided state of the remainder demanded further treatment.

The early studies of the engineers indicated the advisability of a plant designed to remove only the iron and special types of iron removal plants similar to coke filters or Rieslers were considered. However, the ease with which the water could be softened influenced their recommendation for an iron removal and softening plant, using coagulation, sedimentation and filtration.

Several years elapsed after these first studies. In the meantime the rapid growth in demand indicated that the present well supply will in the near future reach its economical limit of development. In this event the Sangamon River water can be used and will probably become the principal source of supply.

The Sangamon River water is much softer than the well water, but very turbid and poor in sanitary quality. Samples indicate a range of hardness from 137 to 286 parts per million and a total mineral content, varying from 193 parts per million to 319 parts per million.

The sanitary quality of the river water is gradually being improved by the construction of sewage disposal plants by the principal towns along the river have heretofore been the source of contamination. With the completion of Springfield's new sanitary program, the sanitary quality of the river water will be much further improved.

Basis of Design

In view of the present source of supply, the wells and galleries and of the possible future source, the Sangamon River, the new treatment plant has been designed with the idea of removing both the iron and hardness from the underground water and the turbidity and hardness from the river water.

Inasmuch as the sulphate or permanent hardness is only 15 per cent of the total hardness of the well water, no attempt has been made to remove the magnesium sulphate. However, it is planned, by lime treatment, to remove practically all the hardness due to calcium bicarbonate and part of that due to magnesium bicarbonate, giving a final product with a hardness between 100 and 125 parts per million. In this process, the iron will also be eliminated. Alum will be added wherever necessary to aid in coagulation.

The river water can be treated in much the same way. Its lower degree of hardness, however, will require less lime but the turbidity will probably call for the use of more alum.

The water will be pumped directly from the wells or river to the new treatment plant where it will be received in the chemical dosing well. The lime and

alum will be applied here and the water will then flow to the coagulation tanks. There are two of these tanks of the mechanical agitation type. The period of retention is 40 minutes during which time the water will be thoroughly agitated by motor driven paddles, revolving at a rate of one-half a revolution per minute. Eighty to 90 per cent of the softening will be accomplished in these tanks, depending mainly upon the temperature of the water.

Clarifiers

From the coagulation tanks the water will next pass to the clarifiers. These basins are each 63 ft. square and 15 ft. deep at the center, giving a retention period of 1 hour and 40 minutes. An unusual feature of their construction is the use of concrete arches to support the clarifier mechanism.

Over 90 per cent of the settleable solids will be deposited in these basins. The sludge will be removed by two Dorrco diaphragm pumps, arranged to discharge into the sewer or to return the sludge by short passages to the coagulation tanks where unspent lime may be used. The pumps are housed in a small building near by, which also contains control valves and the motors driving the paddle mechanism of the coagulation tanks.

Settling Basins

From the clarifiers, the water will flow to the settling basins. These basins provide further capacity for sedimentation and compensate for any unequal dosage of chemical or for change in effectiveness of chemicals due to change in the temperature of the water. There are two of these basins, each 70 by 135 ft. by 12 ft. deep, providing a theoretical detention period of 3 hours and 50 minutes.

Carbonation Chambers

Water will be taken off the settling basins over skimming weirs and conducted to the carbonation chambers. These chambers are also in duplicate and are so baffled that the water will travel at a very low velocity, approximately 140 ft. over a submerged grid system from which carbon dioxide gas will be discharged.

This treatment is intended to prevent the after formation of lime or carbonate deposits on the filter sand or in the water mains. When the water reaches the carbonation chambers, under the most favorable conditions, only about 90 to 95 per cent of the softening reaction has been completed. The carbon dioxide will be introduced to reverse this reaction and prevent its going to completion on the filter beds.

Carbon dioxide will be supplied from a small gas generating plant, equipped with a small gas producer burning coke. The gas will be passed through a scrubber and forced to the carbonation chamber by means of a motor operated blower. The capacity of the generator will be 3,500 lbs. of CO^2 gas per day.

From the carbonation chambers, the water will be conducted to the filter house through a 42-in. cast iron pipe.

Filters

The filter house is a concrete brick structure 60 ft. by 100 ft., housing eight one and one-half million gal. filter units. The filters are arranged on each side of a central pipe gallery and are entirely within the building. Water will be distributed to the units from a central conduit located directly under the operating floor. The filters themselves are 29 ft. by 21 ft. and are designed to operate at a rate of 2 gals. per sq. ft. per min. Each filter is divided into two compartments by a central wash gullet under which is the effluent conduit. The filtering medium consists of 30 ins. of sand and 18 ins. of graded gravel. The underdrains are 3-in. perforated cast iron pipes. The rate-of-flow controllers are of the Venturi type with generous capacity and low loss-of-head.

The controllers will discharge into the clear well conduit located under the pipe gallery floor and leading to the clear well. The filters will be washed by a high velocity wash from an elevated tank. Wash water will be conducted from the filters through sewer conduits under the pipe gallery floor to the river. During high stages in the river, the wash water will be directed to an underground sump from which it will be pumped back into the chemical dosing well to pass through the plant again.

Clear Well

The clear well is a novel feature of the plant. This basin has a capacity of 2,000,000 gals., is 180 ft. square and 10 ft. deep. Floor and roof are of heavy flat slab design and the entire structure is loaded with 8 ft. of earth to overcome the buoyant effect of ground water during extreme high water stage in the river.

Chemical Plant

Special provision is made to handle the large quantities of chemicals required for the softening process.

At normal capacity 6 to 8 tons of quicklime will be required per day. At Springfield the use of quick lime offers a saving of about $6 per ton over hydrated lime. The lime will be delivered in carload lots, crushed to 1 in. smaller in size. Unloading will be accomplished by means of a power shovel bucket elevator and screw conveyor or possibly by an air conveyor which will discharge into the storage bin. There are three of these bins, each with a capacity of two carloads.

Directly under each bin is a hopper scale of 1,000 lbs. capacity. This scale is fitted with a revolving bucket which will discharge 2 lbs. of lime per revolution, into the slaking tank, where hot water will be added and the mixture thoroughly stirred by revolving rakes until the lime is slaked. The slakers are arranged so that they may be operated either on the fill-and-draw plan or continuously. Under each slaker is a horizontal solution tank which will receive the discharge from the slaking tank and in which the milk of lime will be brought to a standard solution. These tanks are equipped with paddles revolving about a horizontal axis. This type of tank is designed to prevent the stratification of the milk of lime solution.

Each lime handling unit, consisting of scale, slaking tank and solution tank, has its own individual motor for power. All valves, levers and switches controlling the unit are grouped together for convenient operation.

From the solution tanks, the milk of lime will be lifted by means of steam operated ejectors to the lime feeders located over the dosing well. These feeders are convenient to the raw water meter, thus enabling the operator to proportion easily the lime feed to the amount of raw water pumped.

Alum will be stored on the second floor of the head house and will be fed by means of dry feed machines into the dosing well. A small chlorine room equipped with exhaust fan is provided in the basement of the head house. Chlorine gas will be fed by means of a Wallace & Tiernan type MSV chlorinator, which is located conveniently on the first floor.

In planning the plant layout, the engineers have provided for future extensions which will double the present capacity of the plant. These extensions can be made without interfering whatever with the operation of the part now under construction. Particular attention has been given to the operating centers of the plant. The laboratory is located in the head house convenient to the chemical preparation and dosing apparatus. An office is also provided to serve the chemist and the chief engineer.

Architectural Features

Architectural features of the buildings were given careful consideration. All buildings are substantial, fireproof structures of concrete and brick wtih cement tile roofs and cut stone trim. The exterior treatment of buildings is designed to give a pleasing appearance without in any way detracting from the utilitarian character of the structures. The interior of the filter house follows out the same idea. Interior walls are of a good grade of face brick. Floors are terrazzo. All filter beds are inclosed with ornamental iron railing. Filter operating tables are marble, with mahogany doors and nickle trimmings.

In the head house, the entrance lobby, office and laboratory are terrazzo floors and sand finish plastered walls and ceilings. Special provisions have been made to confine the lime-dust during operation of apparatus. The chemical preparation room is separated from other parts of the head house by double dust-tight doors.

The main buildings are set well back from the roadway and afford opportunity for beautification of lawns and surrounding grounds.

Special Features of Design

The special features of the design which warrant emphasis are:

(1) The plant can be very easily enlarged to twice its present capacity.

(2) All basins, tanks, and operating mechanism are in duplicate.

(3) Mechanical agitation is employed in the coagulation process.

(4) Clarifiers are used to keep sedimentation 100 per cent efficient.

(5) Carbonation is provided to prevent after-deposit of lime.

(6) Ample clear well storage is incorporated.

(7) Lime handling equipment is designed to use quicklime at a considerable saving over hydrated lime.

(8) Architectural and landscape features are carefully considered.

The city officials of Springfield, realizing that the problems of treating water

at Springfield are similar to those found in many other parts of Illinois, have sought to provide a plant that would serve as a model for other municipalities of the state.

The foregoing paper by Mr. Timanus was read at the recent annual meeting of the Illinois section of the American Water Works Association.

STANDARDIZATION OF MANHOLE FRAMES AND COVERS

As the result of a request from the Division of Simplified Practice, a sectional committee on the standardization of manhole frames and covers is being organized under the procedure of the American Engineering Standards Committee, 29 W. 39th St., New York, N. Y. The Telephone Group, consisting of the Bell Telephone System and the United States Independent Telephone Association are acting as sponsors for the undertaking, and the American Society of Civil Engineers has been invited to associate itself in the work as joint sponsor. The Sectional Committee will contain representatives of the utility associations and other organizations interested in the subject.

As the result of a preliminary survey through extensive correspondence and a preliminary conference of interested organizations, the Division of Simplified Practice developed the fact that the need for simplification or standardization of practice was widely recognized. For example: The Flockhart Foundry Company found that they are now manufacturing 140 types of circular frames and covers, in addition to many square and rectangular types, a condition requiring the carrying of a stock of 2,000 patterns and involving an extraordinarily high seasonal variation in output.

These conditions bring out with striking clearness one of the important advantages of standardization, which is that it stabilizes production and employment by broadening the possible market, and by making it safe for the manufacturer to accumulate stock during periods of slack orders to an extent which would not be safe with an unstandardized product.

HIGHWAY FINANCE REPORT OF NATIONAL TAX ASSOCIATION

(Editor's Note: The following report of the Highway Finance Committee of the National Tax Association was adopted at the meeting of the Association held in St. Louis in September, 1924.)

I. The Problem

The tremendous development of motor transportation in the United States has brought incalculable gains to the American people. Where means of rapid transportation of men and goods already existed, it supplemented them by providing feeders and connections, by offering for goods alternative and more flexible service, and for men what is often a more pleasant, faster or cheaper method of travel than what was already available. It facilitated the extension of the area of metropolitan units of settlement, thus serving to check the growing congestion of population in the older portions of urban centers. It brought town and country into closer touch. It has in considerable degree destroyed the historic isolation of the American farmer, and by bringing him into closer contact with his neighbor, with the railroad, and with the town, has wrought significant changes in his social and economic life. The development of motor transportation has been one of the outstanding factors in the economic history of the American people in the last two decades, and it is difficult to overestimate the contribution it has made to American social and economic welfare.

So rapid a development of motor transportation as had occurred would not have been possible, however, without the exercise of tremendous initiative and enterprise on the part of government in supplying the highway extensions and improvements needed to serve the new traffic demands. How great have been the demands made upon the state by motor transportation is indicated by the following estimates of the annual highway expenditures of American federal, state and local governments, exclusive of municipalities, and exclusive of interest on highway indebtedness, from 1904 to date.

Year	Amount in Millions of Dollars
1904	80
1914	240
1917	280
1918	286
1919	390

1920	500
1921	947
1922	898
1923	940

(Note: In 1923 interest on highway indebtedness accounted for about $60,000,000 more.)

There have nevertheless probably been relatively few instances in which the construction and maintenance of improved highways suitable for motor traffic have been carried beyond the existing or immediately prospective reasonable needs. The evidence, in fact, all points strongly to the counter conclusion that highway construction and provision for proper maintenance have in general lagged behind traffic needs, and there is not yet any reason to anticipate an early substantial reduction in the annual rate of highway expenditures, although the peak has probably been reached. No part of this increase in highway expenditures can be attributed to any factor other than the new demands of automobile traffic, for the total annual expenditures on highways prior to the advent of the automobile did not in any year reach 10 per cent of the present annual expenditures and horse traffic has virtually disappeared from improved roads.

Highway Results Justify Expenditures

This increase in hifhway expenditures has in the main been justified by its results. But the main burden of financing these expenditures, which are huge in amount, falls now and must necessarily continue to fall, on state and local governments. These are already groaning under the financial burdens which they bear and their existing revenue systems, and in some cases even their basic economic structure, are inadequate to enable them satisfactorily to bear still greater tax burdens. The situation makes urgent a thorough survey of the problem, with particular reference to the question of economy in highway expenditure, the resort to borrowing as a means of financing highway construction and maintenance, the equitable apportionment among taxpayers of the taxes necessary to provide highway revenue, the types of taxes to be used for this purpose, and the means whereby there can be secured an adequate degree of coordination of federal, state and local highway expenditures and revenues. Your committee presents this report as a modest contribution to this task.

II. Economy in Highway Expenditures

Highway economy does not mean highway parsimony. Where highway improvements will be worth more than their cost, it is true economy to make the necessary expenditures; it is extravagance to withhold them or to spend less than the minimum necessary adequately to finance such highway improvements as are economically justified. Retarded highway development means costly maintenance of outworn highways, excessive operating costs to automobile users, and arrested growth of such industrial and pleasurable activities as are dependent on advanced means of transportation. But there are many other avenues of waste in highway finance, some of which have been muchly travelled. Our experience with the special problems of automobile highway construction and maintenance has been, perhaps, of too short duration to permit of the detection of all of these avenues of waste or to justify the dogmatic formulation of the principles which should be followed at every time and in every place in the expenditure of highway funds. Some problems, however, have been more or less clearly discerned, and for a few of these the available fund of experience has already disclosed effective remedies.

No primary highway should be constructed or substantially improved until after an economic survey of existing and potential traffic, conducted by competent technicians along the lines developed by the Federal Bureau of Public Roads and the more efficient of the State Highway Commissions, has shown that the improvement is economically warranted and has indicated for what volume and character of traffic it should be designed. The existing volume of traffic prior to the making of the improvement should not, of course, be alone relied upon in making the necessary decisions, for the prospective growth in population and in production should be taken into account as well as the stimulus to traffic resulting directly from the more economical or more convenient mode of transportation brought about by the improvement itself. The mode of construction and especially the type of surfacing to be used should be decided upon only after reference to the results of local research with respect to the comparative costs of construction and of maintenance of the different types. Consideration should always be given to the possibility of the economic utilization of nearby building

material resources, or of other means of transportation than the automobile highway.

The rule that no highway should be constructed or substantially improved until after a scientific survey has shown that the expenditure is economically justified should be strictly enforced and should be made the means of guarding against any unnecessary or unwise extension of existing transportation facilities beyond the reasonable needs of the state or its facilities for payment. It should constantly be borne in mind that one of the urgent needs of American government at the present time is for a reduction of the tax load and a check to the expansion of government indebtedness, with its attendant evils of reckless expenditure, inspired credit, a flood of tax-exempt securities and the legacy to later generations of a debt-liquidation problem of serious proportions. The state and local governments should be on their guard lest in their well-deserved enthusiasm for highways they carry their highway programs beyond their real needs or beyond their means for financing them.

Highway construction and improvement should follow a central and systematic plan in order that individual projects shall eventually develop into a coordinated highway system instead of a haphazard collection of blind alleys and scraps. Once it has been decided, upon the basis of a careful survey, that a proposed highway project is immediately warranted by the traffic needs and potentialities, construction of its main framework as rapidly as is consistent with the maintenance of competitive market conditions for bond flotations, labor and materials is economically urgent, since every mile of improved road adds to the value of the remaining mileage of improved road to which it is supplementary. Piecemeal construction often means wasteful gaps which lessen the serviceability of what has always been built, trunk lines without feeders to bring traffic to them, feeders without access to trunk lines.

It is often desirable that sufficient right-of-way should be acquired when an improvement is first planned to permit of widening of the road surface at some later date to meet the demands of increased traffic without excessive costs for land purchase or condemnation. This practice is especially desirable in urban terminal areas, where successive widenings of the highways are most likely to become urgent and where in the absence of such precautions subsequent widenings are liable to require expensive purchase or condemnation of buildings.

Peak Load Congestion

On highways in the neighborhood of urban centers of population there is likely to be a pronounced peak-load of traffic on summer weekends, and roads which may provide generous accommodation to traffic at other times may at such periods be seriously congested. It is not economically justifiable to try to meet all the demands for ample highway accommodation for peak-load traffic of this character. Where the congestion is, however, confined to a limited mileage, usually the outlet roads for large cities, the provision of a few miles of wider or additional terminal roads, linking up the city streets with the rural highway system, will often be sufficient to reduce the peak-load congestion to tolerable proportions without involving unduly excessive financial burdens on the state. Many urban automobile owners have no opportunity to utilize the rural highways except at week-ends and whatever can reasonably be done to meet their needs should be done.

No highway should be constructed or improved without immediate provision being made for the necessary maintenance to keep it in first-class condition. Adequate maintenance is necessary not only to make possible the complete and satisfactory utilization of the highways, but also to preserve the original highway investment. The construction of expensive highways, which are then permitted to break up and disintegrate because of a desire to "economize" on maintenance costs, is highly wasteful procedure. Another form of waste of highway facilities which is unduly prevalent is the failure to maintain the roads in condition fit for traffic during the winter months. Clearance of snow from the roads is not always economically justifiable, but where winter traffic would be present in volume sufficient to justify snow clearance, if the roads were cleared, and is absent only because they are not cleared, there is a wasteful loss to the community during a part of each year because of the enforced idleness of its highway investment.

Gross Weight Not Determining Factor in Road Wear

The problem of the heavy motor truck is a difficult one, that has led to many popular misconceptions as to the causes

of undue damage to the highways. The heavy truck will here be considered to be the truck whose weight, unloaded, is 5 tons or over and whose weight, with a standard load, is 11 tons or over. Studies made by the Bureau of Public Roads in cooperation with State Highway Departments and others show conclusively that the chief causes of highway deterioration are adverse weather conditions, which result in a breaking up of the subbase, bad soil conditions, lack of maintenance and overloading of the road or the vehicle. Mere gross weight is not in itself the determining factor. Where the potential volume of freight traffic justifies the construction of roads designed to carry such vehicles, heavy trucks provide an efficient and economical means of freight transportation. But heavy traffic can do great damage to improved roads not designed for such traffic, if weather and soil conditions are adverse, or if traffic regulation is not adequate. The construction of roads, capable of handling, without excessive maintenance costs, a substantial amount of such traffic requires heavy additional expenditures for extra depth of surfacing and width of road. Sufficient economic justification for the construction of roads designed to handle heavy truck traffic ordinarily exists only in limited areas, such as densely populated industrial centers and trunk routes connecting large urban districts not too distant from each other. On ordinary improved highways not designed for such traffic, heavy trucks should be admitted only where there exist emergency or special needs for their operation, and only under special permit and subject to close regulation by the highway officials as to character and distribution of the load, condition of the tires, speed, condition of the roads, etc. Under such regulation even a light-surfaced road can carry a substantial amount of heavy truck traffic without excessive wear on the road.

Regulation of Traffic

There cannot be entirely effective maintenance of our public highways, and above all there cannot be reasonably economical maintenance expense, unless there is adequate legislative provision for the regulation of traffic and adequate machinery, energetically administered, for the enforcement of such legislation. To prevent the uneconomic and unjustifiable wear and tear of highways, size, weight, load, speed, and tire-condition regulation of motor traffic have been found absolutely essential. Effective traffic regulation, on the other hand, is not possible without considerable centralization of highway control. The tendency is strongly in the direction of absolute state control over primary improved roads, and it is a desirable tendency. Uniformity of regulation is desirable not only for the various parts of the highway system within a state but also between states, and the latter type of uniformity can be secured only by voluntary cooperation between the highway authorities of the different states. The regulatory code should not be too rigid and should preferably be left to administrative authorities subject to broad legislative limitations. The variables to be considered as to type of traffic, type of road, season of year, volume of traffic, special circumstances, etc., are too numerous to be dealt with in adequate detail and with sufficient flexibility by legislation. Careful investigations by federal and state highway officials have shown that the great bulk of damage to roads is done by abuse rather than by reasonable use thereof. Traffic regulation should be directed in the main to fostering the maximum use of the available highway facilities and should have a punitive trend only against unreasonable use of roads.

To secure proper direction and economic control of highway expenditures a substantial degree of centralization of administration is necessary. Prior to the coming of motor transportation, roads were, with a few outstanding exceptions, built and maintained by the local communities. The first influence of the advent of motor transportation was to secure the extension and improvement of these local roads, so as to facilitate communication between neighboring communities. Later the counties, and still later the states, assumed some measure of responsibility for and authority over the road system, mainly in order to develop chains of local roads connecting the larger cities. Every state in the Union has now some form of highway department with powers of control ranging from complete authority over minute details of state and local expenditures for construction and maintenance to merely advisory functions for the state highways and no jurisdiction whatsoever over local roads. The trend, however, is decidedly in the direction of greater centralization, in inevitable response to the needs of the situation.

In very recent years all the states, with the co-operation of the Federal Bureau of Public Roads, have planned and have made substantial progress in the construction of thoroughly co-ordinated systems of improved highways, providing both through routes of state and national importance and systems of secondary roads subsidiary to those through routes. Some states have initiated purely state projects, going beyond the federal plan. The inevitable consequences of local control of primary roads are piecemeal construction, inadequate and varying construction and maintenance standards, lack of co-ordination and the continuance of costly gaps in the system, excessive costs because of lack of knowledge of recent developments and of the results of scientific tests and investigations. There should be state control of all roads which are not almost wholly of a strictly local character serving merely the community in which they are situated. As population and motor traffic grow, more and more of what are now local roads will be absorbed into the state highway systems and should come under state control or supervision. Even before local roads are placed under any degree of mandatory state supervision, the state highway departments should develop facilities for giving to local authorities, in systematic fashion, guidance with respect to most suitable road materials, mode and location of road construction, material and labor prices, bond flotations for roads, maintenance standards, etc.

III. The Borrowing vs. the Pay-As-You-Go Methods of Highway Financing

The modern automobile highway is in large part a "permanent" improvement. The location, right-of-way, subgrade, drainage and many of the structures are permanent, and competent engineers estimate the permanent portion of improved highways to be from 40 to 60 per cent of the total construction expense. Maintenance expenditures should be sufficient to preserve the improvement in as good shape as when first constructed. The generally accepted rule that the maturity of bonds for financing improvements should not extend beyond the life of the improvement fails, therefore, to set an adequate limit to the resort to borrowing to finance highway construction and guidance must be sought in more fundamental principles in determining the extent to which borrowing is justified.

During the initial period of construction of an extensive system of improved highways, densely populated and rapidly growing states, and states where the immediate need for the construction of improved highways is urgent, it would be unwise to attempt to finance highway construction wholly or even in large part from current tax revenues. If current revenues are relied upon under the circumstances, there will result either an intolerable tax burden on the community or else there will be an unreasonable retardation of highway construction, entailing to the community the loss for many years of the advantages of improved means of highway communication. Such a financial policy would be likely to lead, moreover, to piecemeal construction, with the result that the utility of each mile of improved road will for many years be reduced as compared to the possibilities if, once the system were carefully planned, a program of rapid completion of its general framework were embarked upon. States and localities, however, which have already made considerable progress in highway construction and have already passed the peak of new annual mileage, should move gradually toward the pay-as-you-go basis. This could be accomplished partly by shortening the maturity of new bond issues and partly by increasing the proportion of new construction costs met out of current revenues. Maintenance and reconstruction costs should under all normal circumstances, except perhaps where the reconstruction involves a substantial improvement in the more permanent features of the old road, be financed from current revenues.

In more sparsely settled states, where road mileage per capita is great, where there are no large urban centers of population, and where industry is mainly agricultural and specializes in the production for distant markets of a few staple products, the local roads to the railroad stations are by far the most important part of the highway system. In such states the demand for road construction and improvements will continue for decade after decade at a comparatively uniform rate, and improved roads should not be constructed much ahead of the growth of population to utilize them. In such states road construction should be financed with little or no recourse to borrowing.

Loans incurred for highway construction should not have a longer maturity than 30 years, and preferably not more than 20 years, and should be of the serial bond type. While a substantial propor-

tion of the original cost of highway construction is properly to be regarded as a more or less permanent investment, this is not sufficient to justify the resort to bond issues of indefinitely long maturities. Resort to bond issues with excessively long maturities is liable to stimulate reckless and wasteful expenditures, since the resistance of the taxpayer to bond issues is much less than to increases in tax levies. In any case there is comparatively little advantage in the annual cost during the first 20 years of paying for an improvement on a 20 as compared to a 40-year basis, but there is a tremendous difference at the end of the 20 years, depending upon whether the one maturity or the other had been chosen. The accumulation of debt without provision for its early liquidation impairs the credit of the borrowing agency, and if funds are later needed for emergencies or for the new activities which democracy is constantly demanding of government, they will not be obtainable or will be obtainable only at usurious rates. We cannot see clearly enough into the future to be certain that new transportation needs or facilities may not develop which will render obsolete much of our present huge investment in automobile roads. There is always the danger that a highway has not been properly planned and that it may have to be rebuilt in another way or in another location. "As the highway systems are completed, the traffic will become more and more organized, and concentrated on the improved highways. If these systems are not properly selected they will have to be revised and so much of the investment jeopardized," said Thomas H. Macdonald, Director of Federal Bureau of Public Roads, in an address before the United States Chamber of Commerce, May 16, 1922.

IV. Principles of Taxation for Highway Purposes

Until the latter half of the nineteenth century main highways or trunk lines were largely privately constructed and operated and were financed by tolls levied upon the users of the road. Local roads were constructed and maintained as now by the local governments and were financed out of the general local revenues or by special local road taxes payable in labor or in cash. Unsatisfactory maintenance of the trunk roads by their owners and the exaction of extortionate tolls led gradually to the taking over of the roads by the local or county governments, but in the earlier stages even state roads were often financed out of tolls levied on the users. The inconvenience and irritation of the toll system to road users, the growing recognition of the general utility of highways and the general acceptance of the principle that government services should be financed by taxation levied on the ability principle, were all contributing factors in bringing about an almost complete abolition of the toll system and the financing of roads out of the general revenues of the local, and, later, the state governments. Today there survive only slight traces, here and there, confined largely to bridges, of the once-dominant toll system.

The advent of the automobile brought the need of a greatly improved and extended highway system and threw upon the state and local governments a great additional financial burden which, because of their inadequate and obsolete revenue systems, they were ill-prepared to assume. A partial solution was sought in a return to the benefit principle of taxation, a part of the cost of highway financing being thrown on the direct users of the highways, but in the form of special automobile license or registry taxes, and in the last few years by gasoline taxes, without resort again to the abandoned toll system. The tendency toward imposing on automobile owners an increasing portion of the cost of highways is becoming more marked each year. In 1914 the federal and state special taxes on motor vehicles amounted to only 5 per cent of the total highway expenditures; in 1921 this percentage had increased to about 25; in 1923 it reached approximately 38 per cent; in 1924 it promises to equal or surpass 45 per cent. Since about 40 per cent of the highway expenditures are met by borrowings, the time is rapidly approaching when special motor vehicle taxes will equal the expenditures on highways, both primary and local, from current tax receipts.

The varying circumstances in which different states find themselves with respect to highway burdens and the fact also that American public finance is not governed to any important extent by formulas, meritorious or otherwise, but is largely the produce of historical traditions, inertia, and the play of political factors, make it academic to present any rigid formula as the proper solution of the problem of apportionment of highway costs.

(Concluded in May Issue.)

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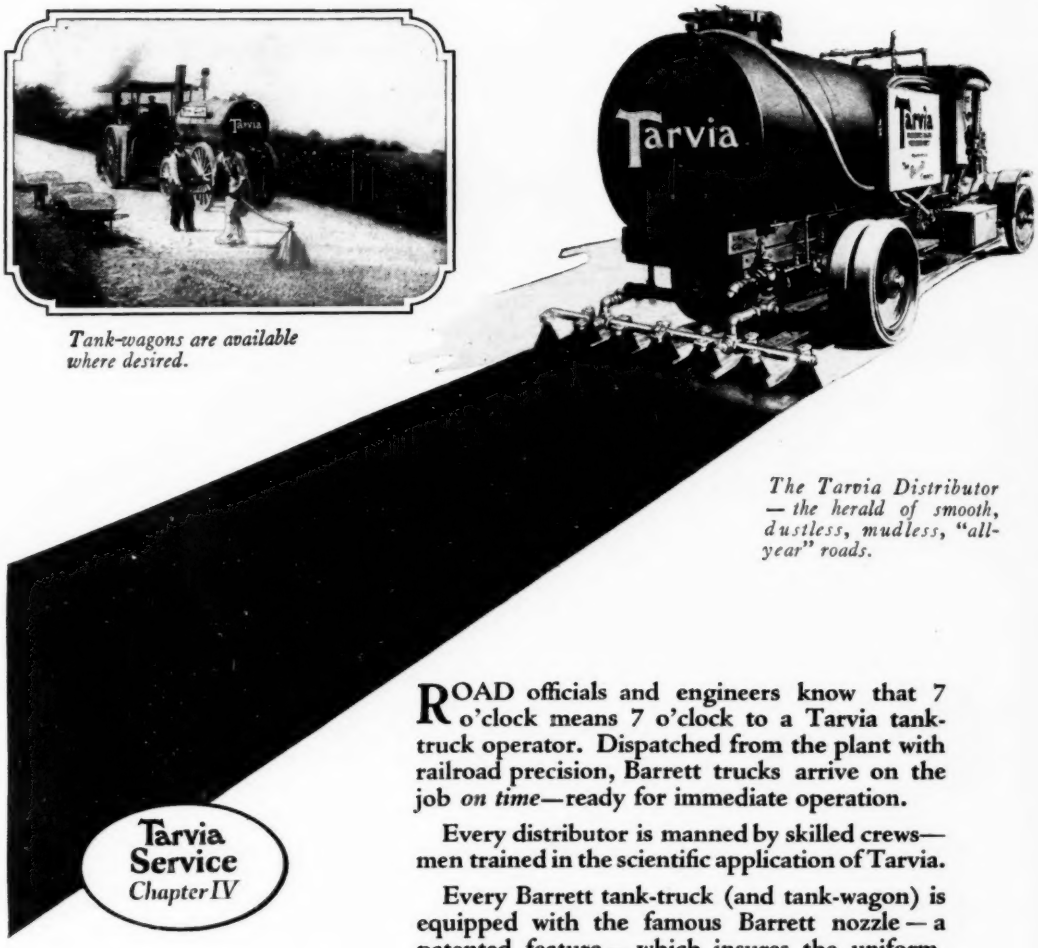

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